Work Instructions

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APPROVED BY Signature: original signed by
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Title: WFF Engineering Drawing Standards

P1. PURPOSE

Over time standards for engineering drawings have evolved differently at the Wallops and Greenbelt facilities to a point where strict adherence to the GSFC Engineering Drawing Standards Manual would be disruptive to work being performed by AETD at WFF. Plans are in place to bring both standards under a common PG. In the interim, this work instruction establishes the conventions to be adhered to by AETD engineering and drafting personnel at Wallops Flight Facility in the preparation, revision and completion of engineering drawings for GSFC products covered by the scope of the GSFC Quality System.

P2. SCOPE

All organizations within the AETD directorate and their contractors following NASA procedures at WFF shall adhere to the requirements of this Work Instruction when preparing engineering drawings.

P3. DEFINITIONS

Engineering drawings - Those drawings that communicate the requirements for the manufacture of the end product items, their assembly, and/or their installation in the end product. This includes electronic schematics and wiring diagrams.

Product Design Lead (PDL) - The manager or leader who has overall responsibility for managing the design activity, managing the technical and organizational interfaces identified during design planning, and where required, forming and leading the Product Design Team. The term refers to flight project managers, mission managers, instrument managers, subsystem technical managers, integrated product development team leaders, lead engineers, etc.

P4. RECORDS, REPORTS AND FORMS

None

P5. SAFETY PRECAUTIONS AND WARNING NOTES

None

P6. REFERENCES

500-PG-8700.2.5 GSFC Engineering Drawing Standards Manual
GSFC X-673-64-IF (Sept 1994)

P7. TOOLS, EQUIPMENT, AND MATERIALS

None

P8. CANCELLATION

P9. INSTRUCTIONS

The PDL shall establish requirements for drawing standards with the understanding that the generally accepted standard is outlined in this manual and should be adhered to whenever practical. These standards will be documented in the PDL's Implementation Plan for the development effort and approved by the customer. For mechanical parts, this will minimize risk of added expense when fabricated at the contractor run base machine shop. At times, project requirements may dictate use of another standard, for example; a) when a customer requires a differing standard, b) when an outside manufacturer is fabricating printed circuit boards or other parts by supplying application software to the designer, c) when a strong heritage exists of performing wiring diagrams or other classes of drawings for particular functions or d) when the project realizes significant economy of time and money by allowing usage of COTS drawing package.

If a project (customer) elects to use another standard, it shall specify what the standard is and document it in the project plan. The project assumes any risk or expense involved in having the drawing translated for purposes of fabrication or integration. All drawings shall contain a title block listing at a minimum; a title, the preparer of the drawing, date of the drawing, revision number and name and revision of any software package used to prepare the drawings.

All drafting practices, unless otherwise stated and defined by the PDL is as follows

1. Drafting Practices

1.1. General

These drafting practices are to be employed in the preparation of drawings by WFF personnel to achieve standardization throughout and result in legible reproductions at the least cost from original drawings.

Drawings must be complete and unambiguous in interpretation. Complete drawings contain or make reference to all data necessary for fabricating and installing the part and, when applicable, the necessary test requirements, procurement requirements, and source.

Orthographic projection shall be used for mechanical engineering drawings. (Certain diagrams, schematics, etc., are excepted.) Although other types of projection, such as isometric, perspective, etc., are not prohibited, their use must be confined to an auxiliary view on a drawing of a complex part when such a view shall aid in visualizing the part.

Drawings need not have three views, i.e., one or two views are permissible for objects that can be completely defined. Complementary notes or dimensions are acceptable in place of the additional views. The rule shall be that only those views shall be drawn that are necessary to convey the required characteristics of the part. Views, dimensions, etc., shall not extend into the margins of the drawing.

1.2. Lines

Acceptable quality of reproductions is dependent on the density and uniformity of line work. Types of lines described below will be used on all drawings other than diagrams, such as schematics, etc.

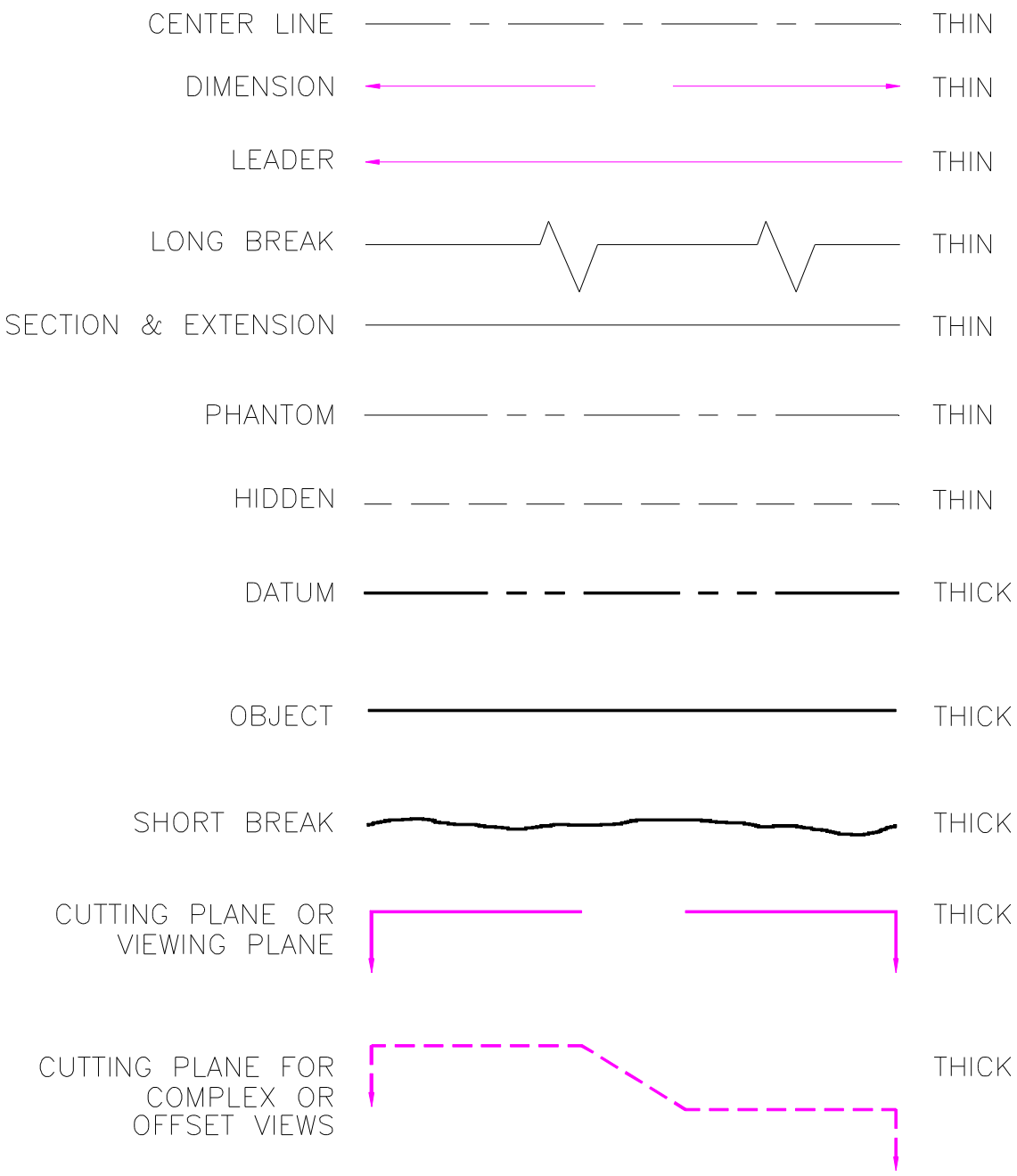


Figure 1: Standard Line Types and Weights

Two widths of lines, i.e., thin and thick, with their widths in the proportions 1:2, shall be used. The actual width of each type of line shall be governed by the size and style of the drawing; the relative widths of the lines shall approximate those shown in Figure 1.

1.2.1. Types of Lines

1.2.1.1. Center Lines

Center lines shall be composed of long and short dashes, alternately and evenly spaced, with a long dash at each end. Very short center lines may be unbroken if there is no confusion with other lines. Center lines shall also be use to indicate the travel of a center. See Figure 2.

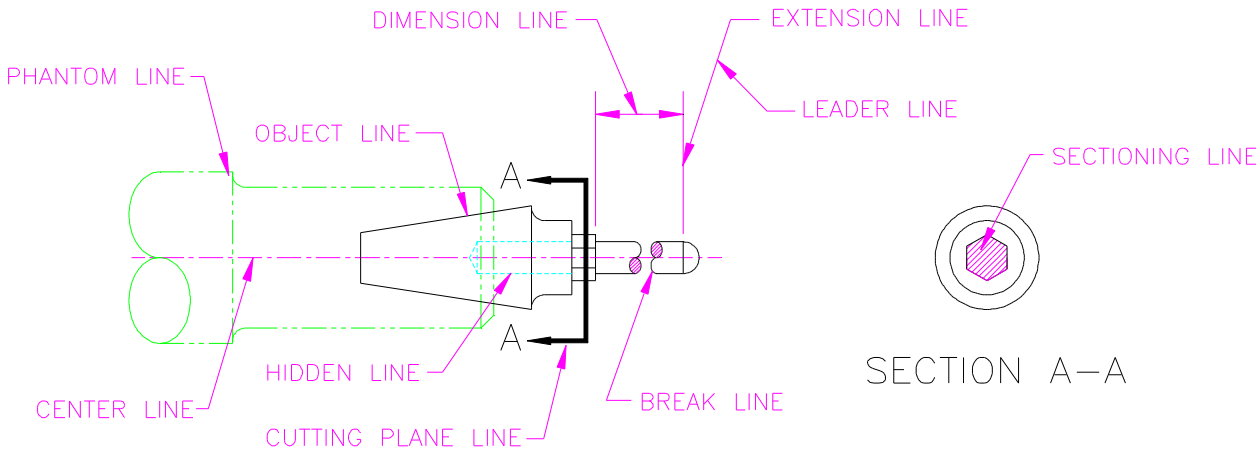


Figure 2: Line Conventions

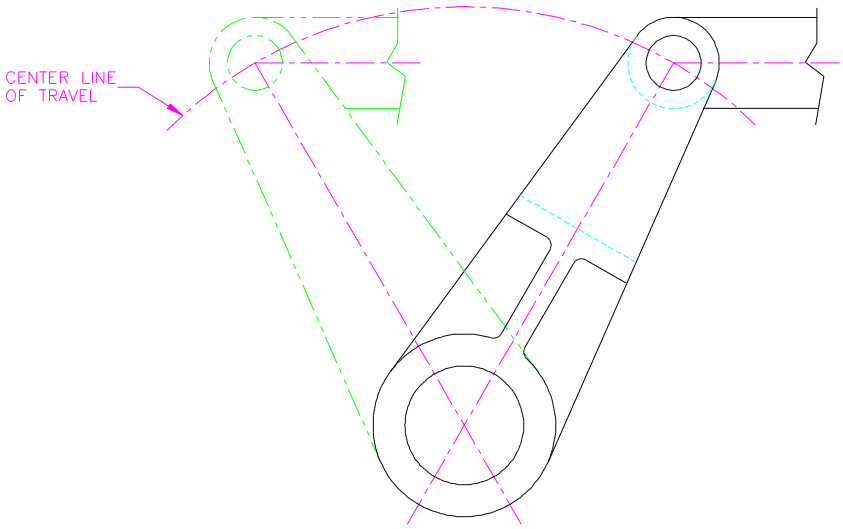


Figure 3: Alternative Position

1.2.1.2. Dimension Lines

Dimension lines shall terminate in arrowheads at each end. They shall be unbroken except where space is required for the dimension. The proper method of showing dimensions and tolerances is explained in Section 1.7 of ANSI Y14.5M-1982.

1.2.1.3. Leaders

Leaders shall be used to indicate a part or portion to which a number, note, or other reference applies and shall terminate in an arrowhead or a dot. Arrowheads must always terminate at a line; dots must be within the outline of an object.

1.2.1.4. Break Lines

Short breaks shall be indicated by solid freehand lines. For long breaks, full ruled lines with freehand zigzags shall be used. Shafts, rods, tubes, etc., which have a portion of their length broken out, shall have the ends of the break drawn as indicated in Figure 4.

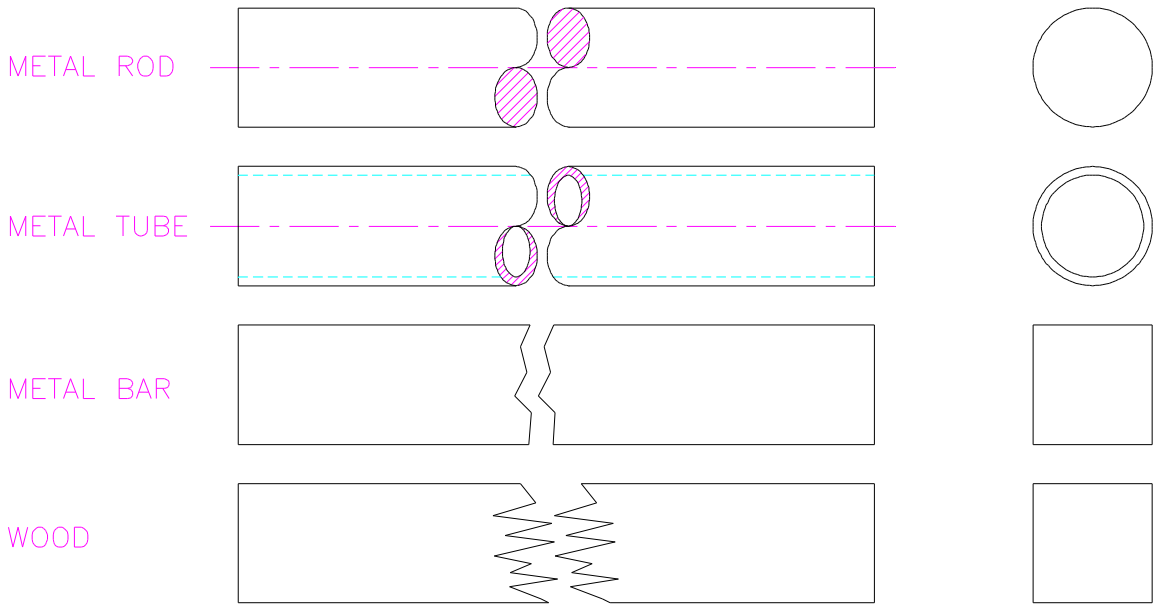


Figure 4: Break Lines

1.2.1.5. Phantom Lines

Phantom lines shall be used to indicate the alternate position of parts of the item delineated, repeated detail, or the relative position of an absent part and shall be composed of alternating one long and two short dashes, evenly spaced, with a long dash at each end. See Figure 5.

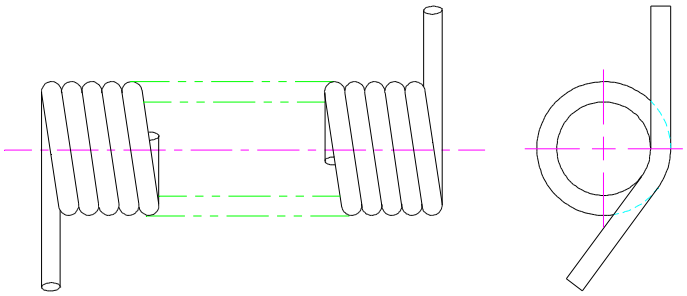


Figure 5: Phantom Lines

1.2.1.6. Sectioning Lines

Sectioning lines shall be used to indicate the exposed surfaces of an object in a sectional view. They are generally thin full lines, but may vary with the kind of material shown in section.

1.2.1.7. Extension Lines

Extension lines are used to indicate the extension of a surface or to point to a location outside the part outline. They start with a short, visible gap from the outline of the part and are usually perpendicular to their associated dimension lines.

1.2.1.8. Hidden Lines

Hidden lines shall consist of short dashes, evenly spaced. These lines are used to show the hidden features of a part. They shall always begin with a dash in contact with the line from which they begin, except when such a dash would form a continuation of a full line. Dashes shall touch at corners, and arcs shall begin with dashes on the tangent points. See Figure 2.

1.2.1.9. Outlines or Visible Lines

The outline or visible line shall be used for all lines on the drawing representing visible lines on the object; see Figure 2.

1.2.1.10. Datum Lines

Datum lines shall be used to indicate the position of a datum plane and shall consist of one long dash and two short dashes, evenly spaced.

1.2.1.11. Cutting Plane/Viewing Plane Lines

The cutting plane lines shall be used to indicate a plane or planes in which a section is taken. The viewing plane lines shall be used to indicate the plane or planes from which a surface or surfaces are viewed. On simple views, the cutting planes shall be indicated as shown in Figure 6.

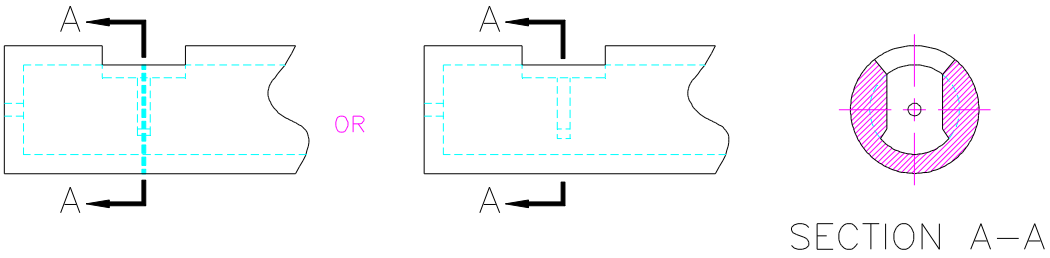


Figure 6: Full Sectional View

On complex views, or when the cutting planes are bent or offset, the cutting planes shall be indicated as shown in Figure 7.

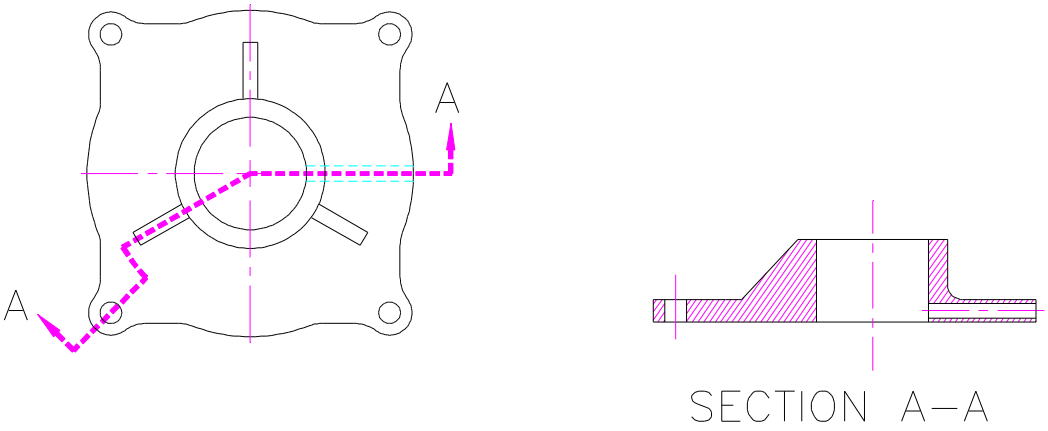


Figure 7: Offset Sections

1.3. Lettering

All lettering shall be uppercase Roman letters, (AutoCAD font romans.txt), and shall always be placed in horizontal reading position whenever practicable. Other than this, lettering shall be in a horizontal reading position when the drawing is rotated 90 degrees clockwise.

Lettering heights and weights shall be as follows:

Drawing number in identification block	.250"	thick
Drawing title	.250"	thick
Drawing subtitle, border, letters, and numerals	.188"	thin
Section, detail, view, and tabulation letters	.250"	thick
Description titles of section, detail, view, and tabulations	.188"	thick
Dimensions, tolerances, notes, subtitles, tables, and revision letters	.125"	thin

1.4. Scale

The following sections describe the conventions to be used for scaling, paper space, and model space as they apply to different elements in an AutoCAD drawing. The reason for such detailed procedures is to make plotting easier. All that will be necessary to get a scaled plot of any particular drawing, will be to load the correct size paper (which will be obvious from the file name) in the plotter and tell AutoCAD to plot full scale. Regardless of actual object size, it will fit on the paper at whatever scale was specified by the drafter.

1.4.1. Geometry

All geometry will always be drawn full scale in model space. This applies to everything from launcher drawings to bracket drawings. No matter what size the original part, it must be entered in the drawing at a one to one ratio. It is also very important that any revisions to a drawing are made to the actual geometry. Do not just change dimension text. The reason for this is that the machine shop will be using software that reads the geometry directly from a drawing and generates instructions for a NC machine to fabricate the part. The NC machine will make a part based on geometry, not what dimensions or notes say.

1.4.2. Title Blocks and Borders

Title blocks and borders will generally be drawn in paper space at full scale. The one exception to this is if the part being drawn will fit within the drawing area at full size. In this case the title block and border can be drawn in model space at full scale.

Once the title block and border is drawn, model space viewports are created at whatever scale is necessary to fit the part within the border. For example, a 17" diameter 30" long skin would require a 1/2 scale model space viewport to fit within a D-size border. A small part may require a 2/1 scale viewport to fill an A-size border. Several viewports can be created at different scales to show things such as joint details.

1.4.3. Notes and Dimensions

Dimensions must be drawn in model space using paper space scaling. This will ensure that dimension text height and arrow size will plot correctly regardless of viewport scale. In other words, 1/8" tall dimension text will actually be 1/8" tall on a full scale plot even though the viewport scale may be set to 1/2.

Notes must be manually sized in relation to the viewport scale. In order for text in a 1/2 scale viewport to actually plot 1/4" tall in a full size plot, text height must be set to 1/2". This only applies to notes in model space when a viewport scale other than 1/1 is used. Notes in paper space can be drawn to the actual required height.

1.5. Positioning the Part on the Drawing

Parts shall usually be positioned on the drawing as they would be seen when viewed from the left or top side with the forward end pointing to the left. If clarity can be greatly improved by a position that results in fewer dotted lines and foreshortened projections, then that position should be used, and the above rule should be disregarded. For example, a connector bracket drawing should be drawn as seen from the front in order to clearly show it's shape.

Skin drawings, payload assembly drawings, etc. will always be drawn with the forward end to the left. Deck drawings and any forward or aft views of skin sections will be drawn with 0 degrees at the top of the page. Angles will increase in the counterclockwise direction when looking aft.

Lathe turned parts are usually drawn with the larger diameters to the left if there is no obvious forward or aft end.

1.5.1. Picturization

Unnecessary detail shall be omitted from all views and sections when clarity shall not be sacrificed and when drafting time shall be reduced. See Figure 8.

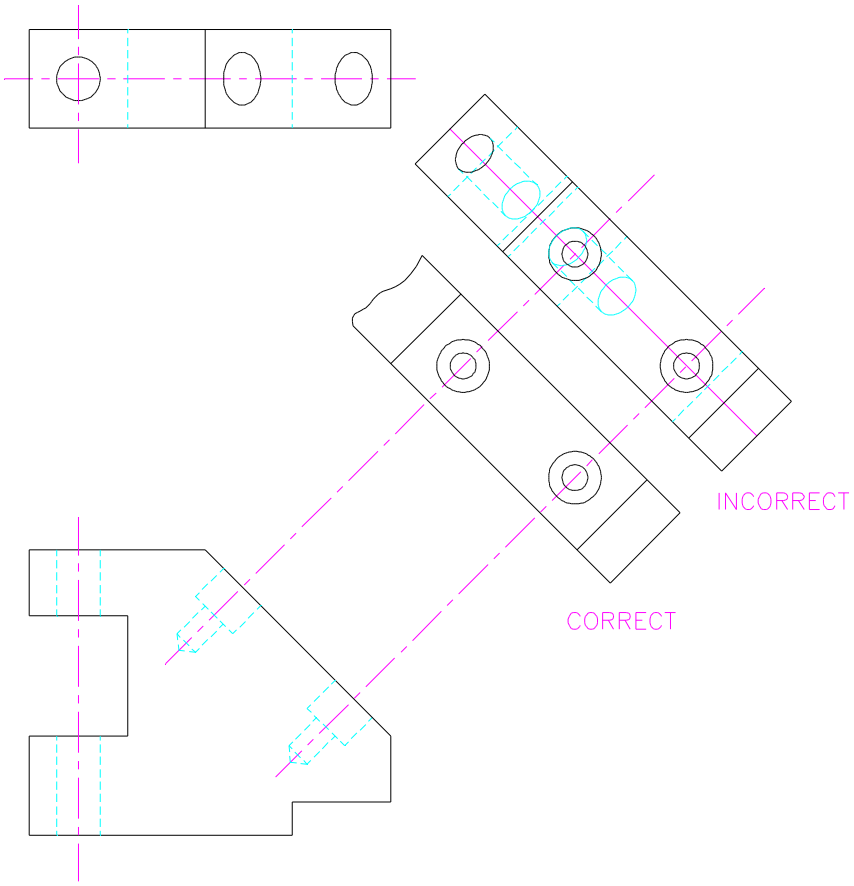


Figure 8: Example of Unnecessary Detail

1.5.2. Sections

1.) A sectional view will be made through an outside view and not through another sectional view. See Figure 9.

2.) The location of a section is indicated by a cutting plane with reference letters and arrowheads showing the direction in which the section is viewed.

3.) Sectional views will not project directly ahead of the cutting plane arrowheads and must be as near as practical to the portions of the drawing that they clarify.

4.) The axes of sectional views should not be rotated; however, the cutting plane may vary in direction as shown below. If views must be rotated, the angle and direction of rotation must be given.

5.) Visible and invisible outlines beyond the cutting plane should not be shown unless necessary for clarification.

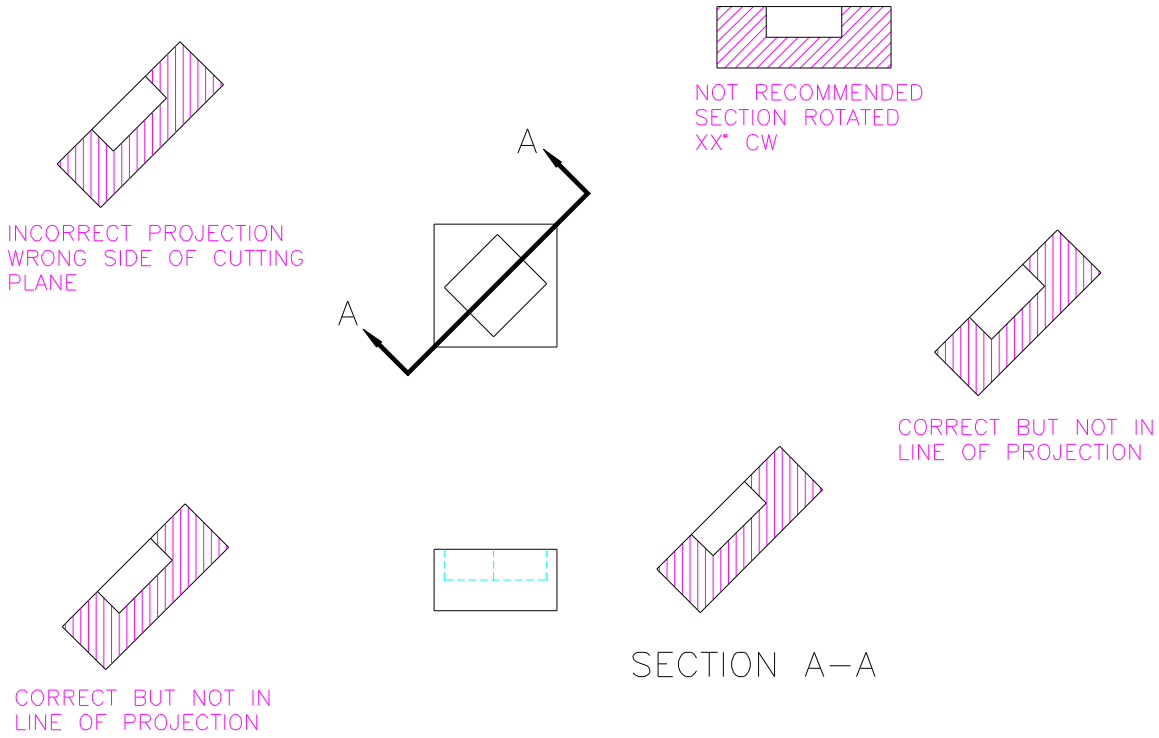


Figure 9: Proper Positioning of Section Views

6.) Shafts, bolts, nuts, etc., which are in a cutting plane will not be cross-hatched.

7.) The AutoCAD crosshatching symbol ANSI31 will be used regardless of material. This consists of regularly spaced continuous lines at a 45 degree angle.

1.5.3. Views

A view is used to enlarge or clarify a portion of the drawing. An example of this is views of umbilical, antenna, and door cutouts on skin drawings. See Figure 10.

1.) Projected views which are adjacent to their origin will not be identified and will not be located directly ahead of viewing plane arrowheads.

2.) "Transported" views or sections are those which are not direct projections. They must be identified where shown, by letters, and at their origin by the cutting plane lines and letters.

3.) Views should not be rotated; however, if views have to be rotated for a legitimate reason, the angle and direction of rotation must be given.

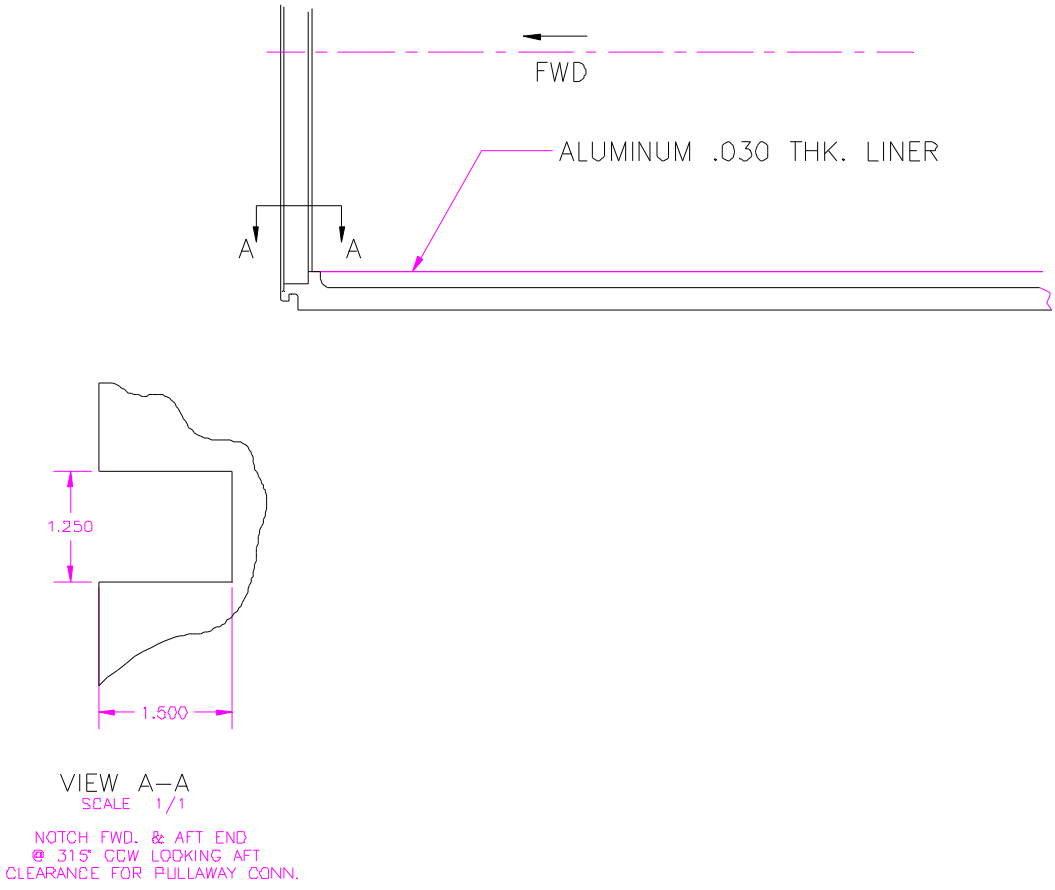


Figure 10: Clarification of a Drawing Using a View

1.5.4. Details

A detail view is a view which shows a portion of another view in the same plane and may or may not show greater detail. An example of this is joint details on a skin drawing. Details will not be rotated. See Figure 11.

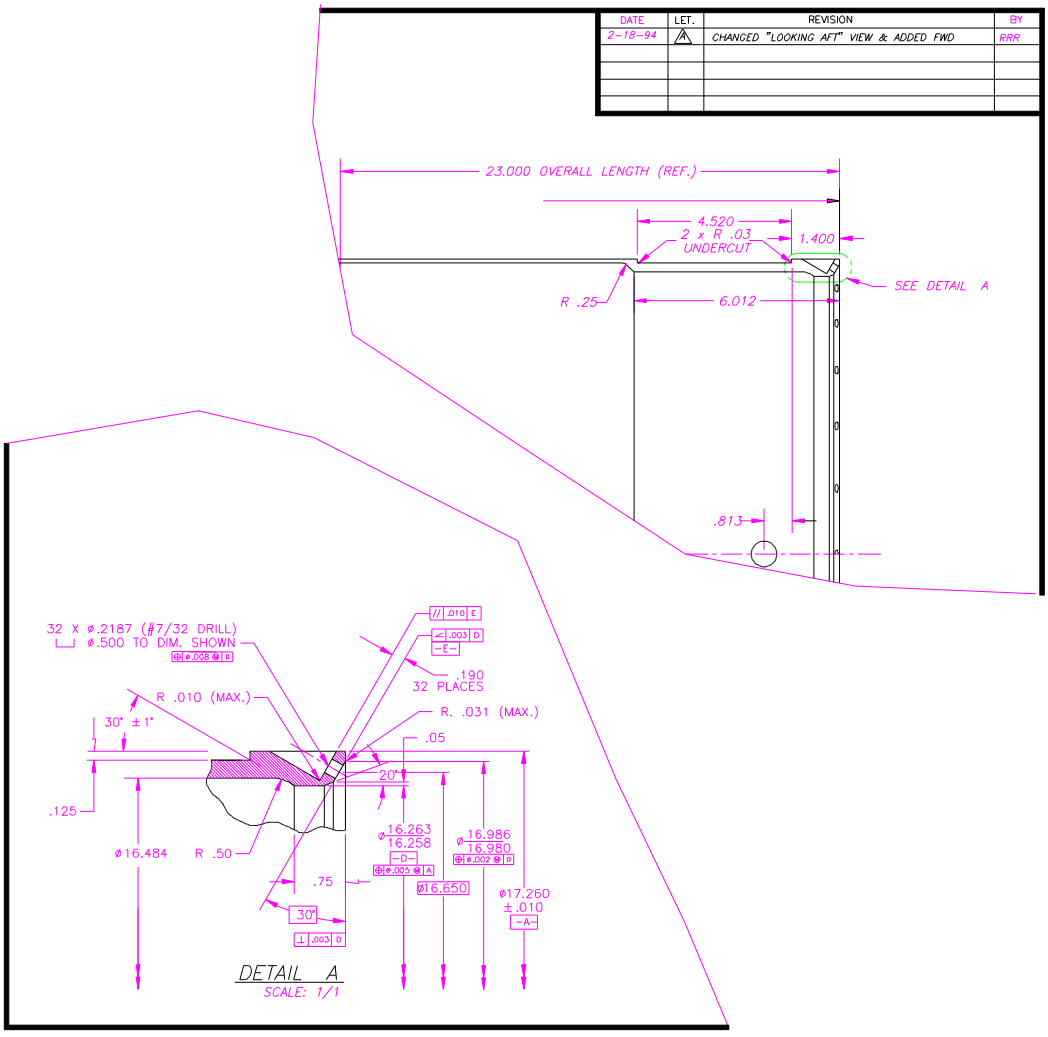


Figure 11: Clarification of a Drawing Using a Detail

1.5.5. Identification of Sections, Views, and Details

1.) Identifying letters for sections, views, and details are assigned in alphabetical sequence as follows: for sections and such views as umbilical and door views, use hyphenated letters. After Z-Z , begin AA-AA, AB-AB, etc.

2.) For encircled details such as a joint detail, use single letters. After Z, begin AA, AB, etc.

3.) The letters I, O, Q, and X, either as single letter or as double letter entries, shall not be used.

1.6. Layer conventions

All drawings will contain at least the following layers using listed linetypes and colors:

Layer Name	Color	Linetype

0 white continuous
This is the default layer created by AutoCAD in all drawings. It will not normally be used for drawing entities.

BORDER white continuous
This layer will contain the title block, standard title block notes, drawing border, revision block, and standard note.

CLINE magenta center
This layer will contain center lines.

DEFPOINTS white continuous
This is a layer created by AutoCAD that contains information used in maintaining associative dimensions. Do not use or try to delete!

DIM magenta continuous
All dimension entities will be put on this layer.

HLINE cyan hidden
All hidden lines will be put on this layer.

NOTE magenta continuous
All notes will be put on this layer.

OBJECT white continuous
This layer will contain the entities describing the actual edges and shape of the part being drawn. It will be used by the machine shop to extract information to

machine the part. Therefore, all entities absolutely must be drawn at a one to one scale.

PLINE green phantom
All phantom lines will be put on this layer.

HATCH	magenta	continuous

All hatching will be put on this layer.

The previous layer definitions will suffice for most part drawings. However, parts such as decks will use additional layers which will be described later. Any other layers that are found desirable to help clarify a part drawing are acceptable providing the standard ones are used for the entities described above.

1.6.1. Types of Drawings

The following sections will outline standards for the most prevalent types of drawings encountered in the WFF Mechanical Systems Section. Any deviations from previously stated standard linetypes, layers, etc. will be detailed below.

1.7. Altered or Selected Vendor Part Drawings

Altered vendor part or selected vendor part drawings shall be prepared on WFF format when an existing vendor part can not be used as is and it is desired to document and control the alteration or selection of the part. The drawing shall specify the part to be altered or selected by vendor number, name, and address and shall completely delineate the alteration or selection. An altered or selected vendor part drawing shall be identified by the words "Altered Vendor Part Drawing" immediately above the title block. The Material box in the title block must contain the words "Purchased Part". See Figure 12.

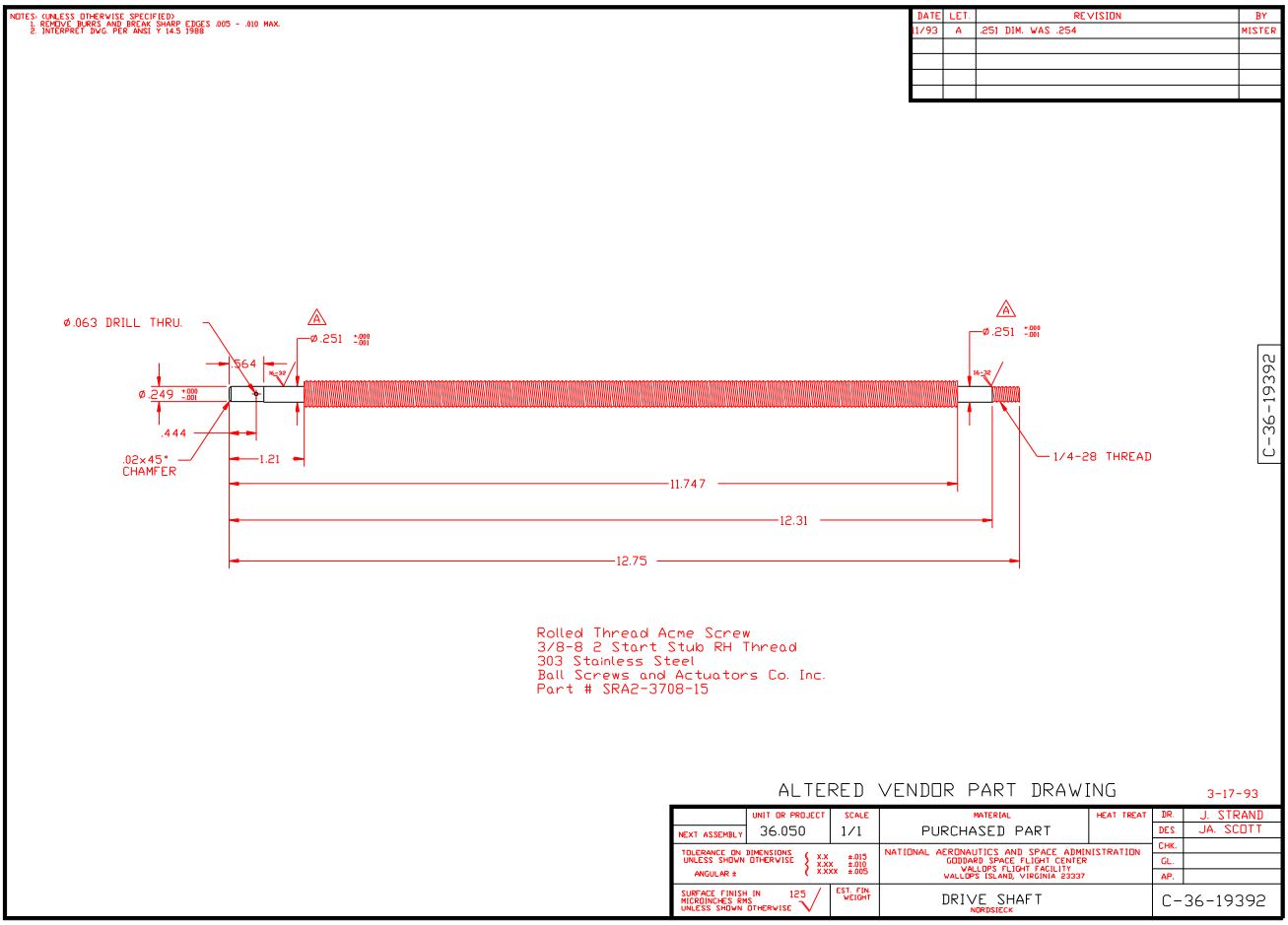
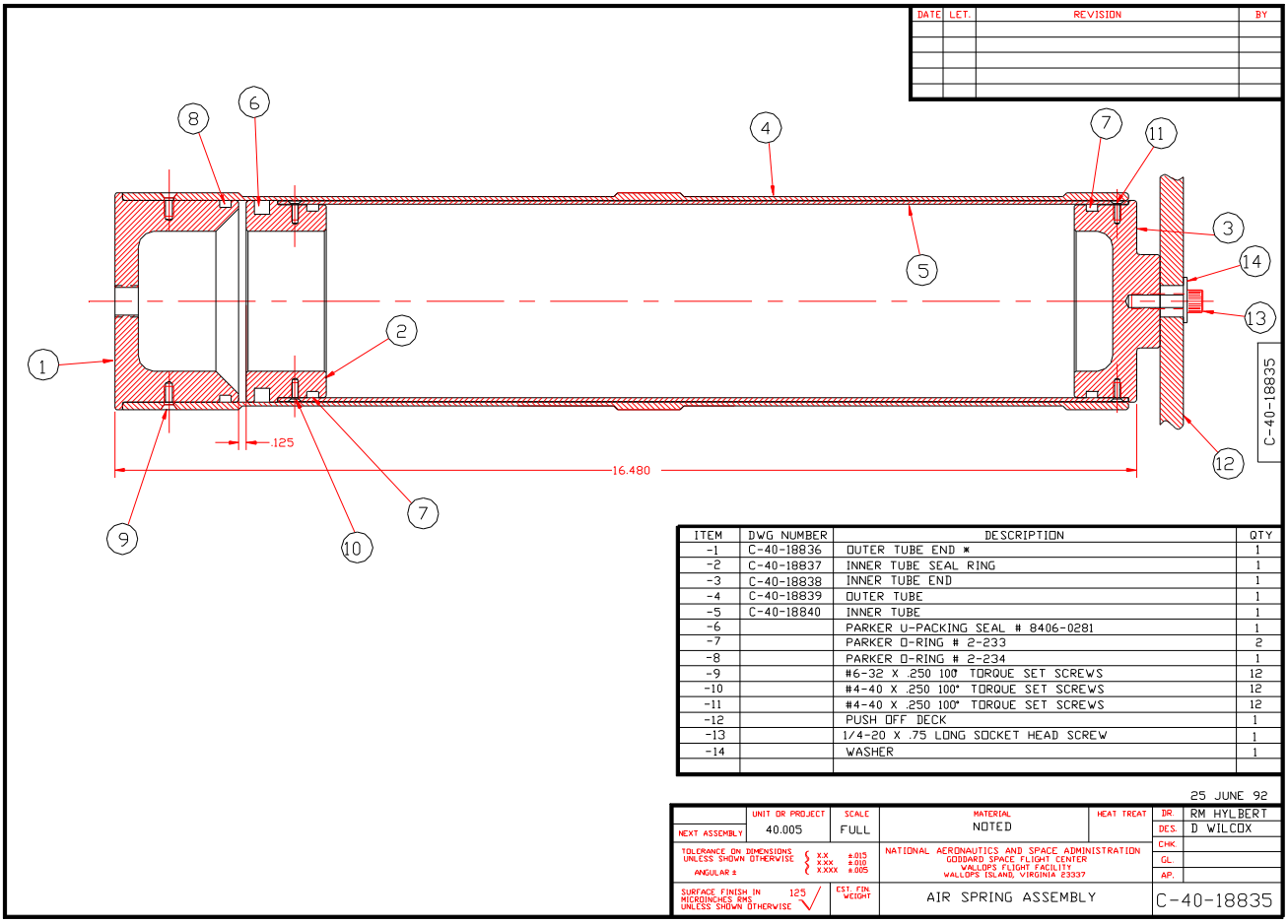


Figure 12: Altered Vendor Part Drawing

1.8. Assembly Drawings

An assembly drawing shows two or more separable parts joined to form a stockable item, or a group of assemblies required to form an assembly of higher order. Figure 13 shows an example of an assembly drawing with an included parts list. In some cases it may be necessary to create a separate parts list, however it is desirable to have the parts list included on the drawing.



ITEM	DWG NUMBER	DESCRIPTION	QTY
-1	C-40-18836	OUTER TUBE END *	1
-2	C-40-18837	INNER TUBE SEAL RING	1
-3	C-40-18838	INNER TUBE END	1
-4	C-40-18839	OUTER TUBE	1
-5	C-40-18840	INNER TUBE	1
-6		PARKER U-PACKING SEAL # 8406-0281	1
-7		PARKER O-RING # 2-233	2
-8		PARKER O-RING # 2-234	1
-9		#6-32 X .250 100° TORQUE SET SCREWS	12
-10		#4-40 X .250 100° TORQUE SET SCREWS	12
-11		#4-40 X .250 100° TORQUE SET SCREWS	12
-12		PUSH OFF DECK	1
-13		1/4-20 X .75 LONG SOCKET HEAD SCREW	1
-14		WASHER	1

Figure 13: Assembly Drawing

1.8.1. Payload Assembly Drawings

A special type of assembly drawing used extensively in the Mechanical Systems Section, is the Payload Assembly drawing. Figure 14 shows a typical drawing. Note the following standards that must be followed when creating this type of drawing:

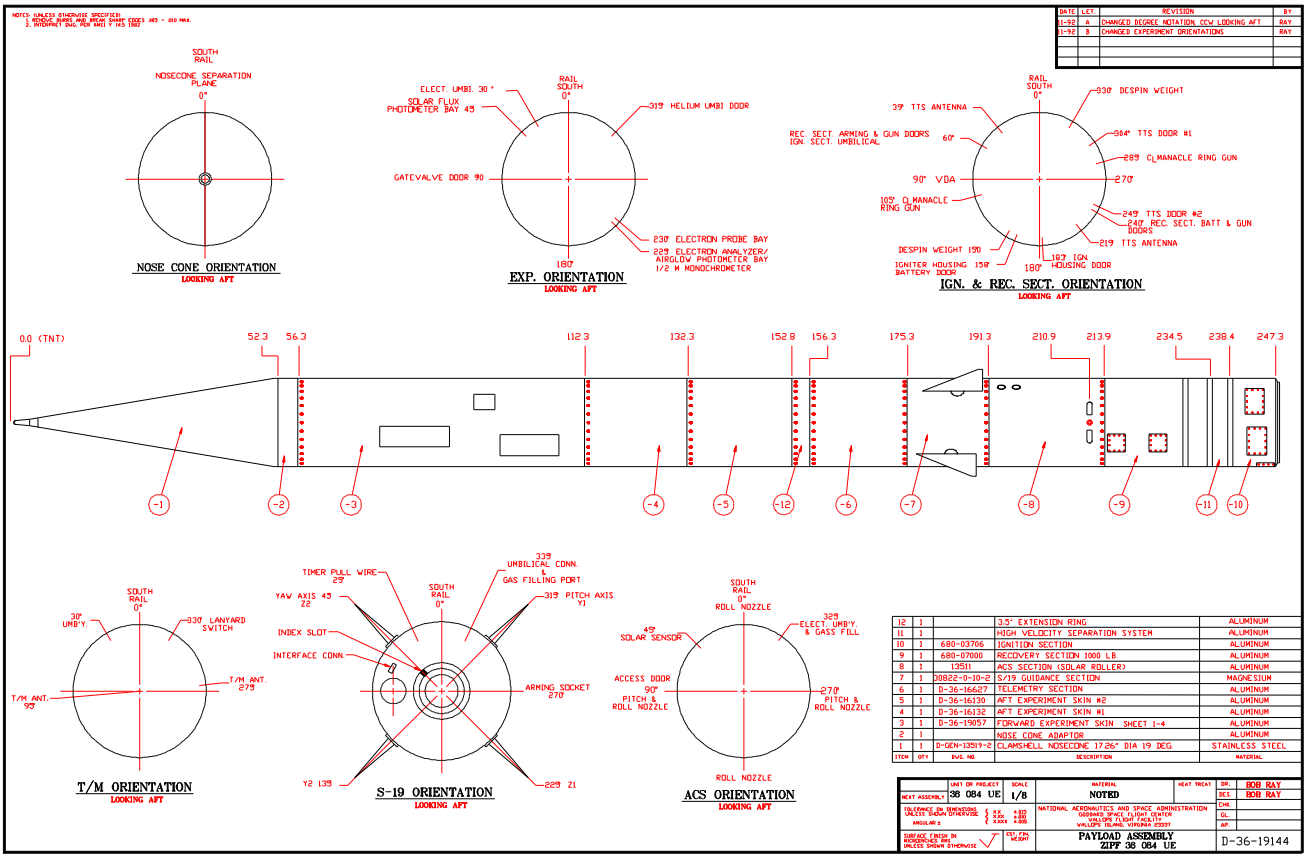


Figure 14: Payload Assembly Drawing

1.) Payload must be oriented with the forward end pointing to the left.

2.) Station locations will start with 0.0" at the theoretical nose tip and increase going to the right. One decimal place accuracy is adequate.

3.) Station locations will be given for every joint, ACS nozzle, door, umbilical, antenna, lanyard switch, vacuum port, etc. Locations of internal features such as decks or experiments may be helpful, but are not required.

4.) Angular locations of all doors, nozzles, umbilicals, antennas, lanyard switches, vacuum ports, etc. will be called out on cross-sectional views. Enough views must be drawn to clearly show angular locations of previously listed features and components.

5.) Orientation of cross-sectional views will be looking aft with angles increasing going counterclockwise.

6.) A parts list must be included on the drawing listing every skin section along with a drawing number (or part number in the case of purchased sections such as the ones from Bristol).

1.9. Detail Drawings

A detail drawing shows all the information necessary for fabricating an item, including the material from which it is made and those finishes, protective coatings and processes required to fabricate the end product. Only one item (detail part) shall be presented per drawing. See Figure 15.

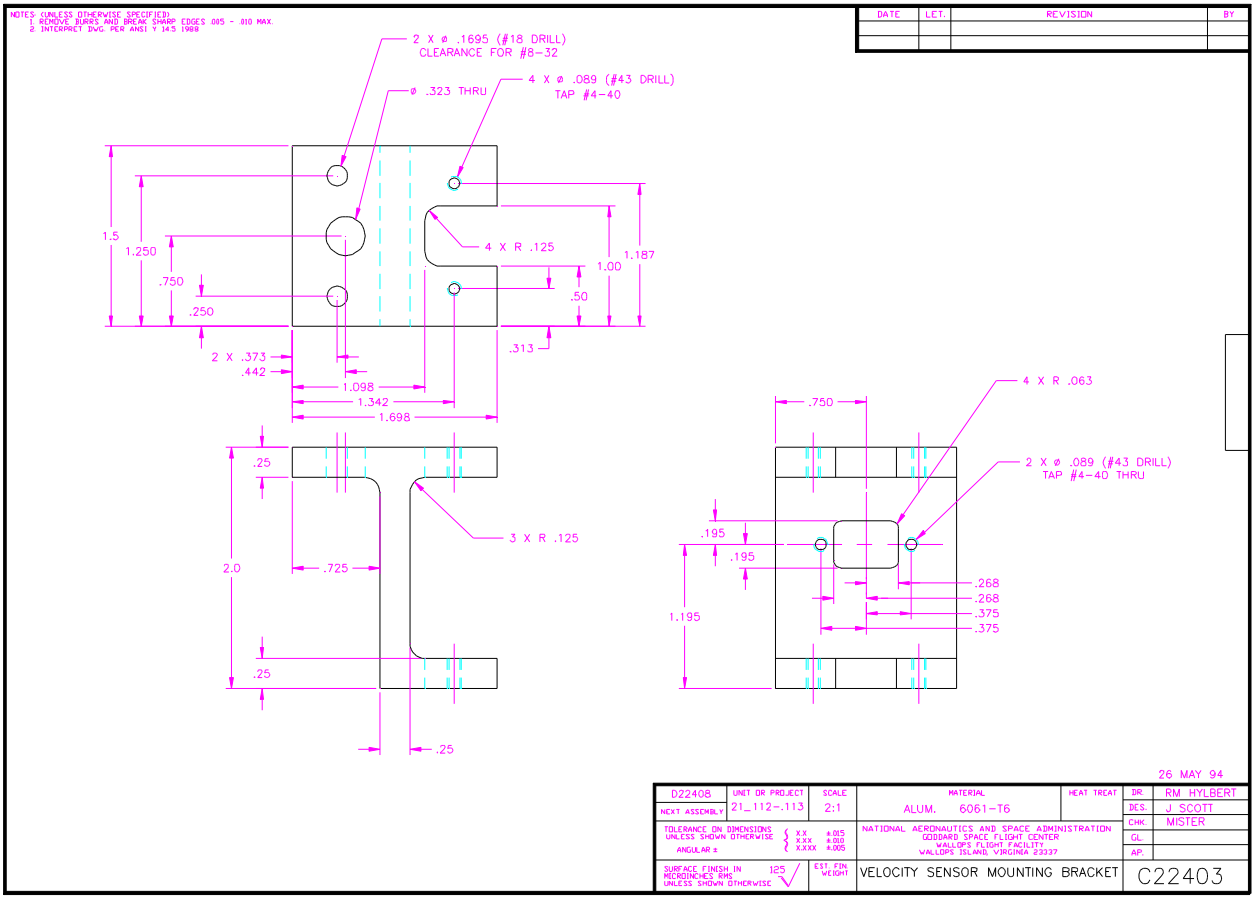


Figure 15: Detail Drawing

In the case of inseparable parts (such as those that are welded, riveted, bonded, or brazed, etc.) which form an integral unit not capable of being disassembled for replacement, refer to the section titled Inseparable Assembly Drawing.

1.9.1. Skin Details

In order to facilitate the machining of skin sections with the new computerized milling machinery, skin drawings will consist of at least two sheets. The first will show a full cross section view of the skin with required end views and all information required for performing lathe machining operations. The second will show a flat layout of the skin. If necessary, a third sheet will show details such as access door dimensions, umbilical cutouts, antenna cutouts, etc. One exception to this rule is transition skins. These will not be required to have a flat layout drawn. SmartCAM software is unable to wrap a flat layout of a tapered cylinder.

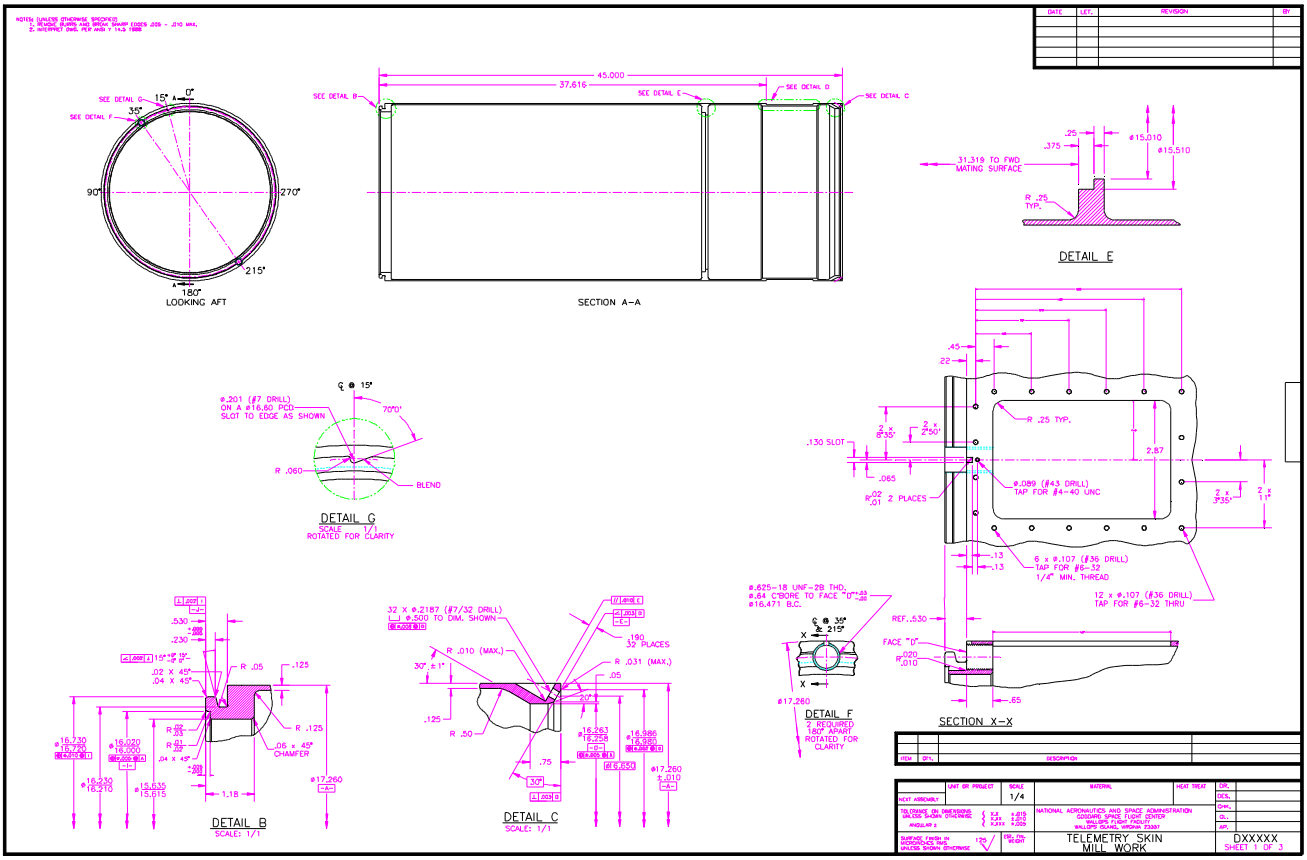


Figure 16: Sheet One of a Typical Skin Drawing

An example of a typical skin drawing sheet one is shown in Fig. 16. It will conform to the following standards:

1.) A full sectional view will be shown, as well as any end views that are required to detail machining on the end of the skin. The section will be taken at a location on the skin that shows the minimum ID required.

2.) An overall length dimension will be included in a prominent location.

3.) Full size joint details will be included for each end of the skin. These details can be inserted as blocks from the G:\JOINTS directory.

4.) Full size details will also be included for such things as flanges machined into the skin.

Figure 17 shows sheet two of a typical sounding rocket skin drawing. The following standards will be followed when creating this drawing:

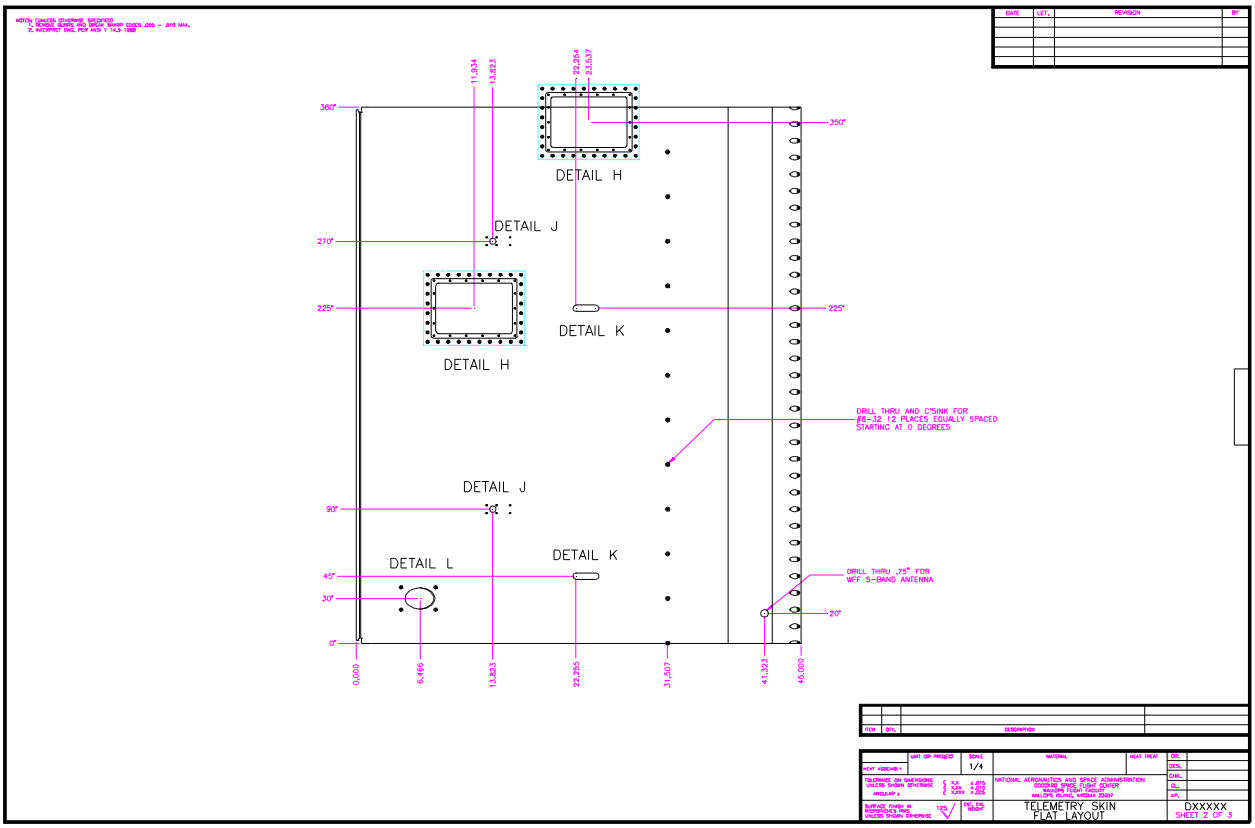


Fig. 17: Sheet Two of a Typical Skin Drawing

1.) Flat layout will be oriented with forward to the left. This will result in dimensions in inches along the horizontal axis and degrees along the vertical axis. Zero degrees will be towards the bottom of the page increasing going up, and zero inches will be towards the left, increasing to the right.

2.) The vertical axis dimensions will be calculated assuming all features are on the outside surface of the skin. For example, a door mounting hole in a 17.26" diameter skin doubler, which is 1/8" below the outer surface, at 140°, would be located on the drawing 21.083" from the bottom edge of the flat layout. This can be calculated from the following equation:

L in. = (.01745)(rad.)(angle) = (.01745)(17.26/2)(140) = 21.083"

It is critical that details on the flat layout be drawn in the correct locations since the CAD/CAM software mathematically wraps this two dimensional drawing around a 17.26" diameter cylinder and generates code for the NC machine to mill the cutouts and drill the holes.

3.) When dimensioning the flat layout, use a detail's center as a reference. Generally, each detail must have two dimensions; an angular location of its center, and a distance from the forward mating surface to its center. However, in the case of details such as hole patterns, it is sufficient to give a linear distance to the center of the row of holes along with a note detailing size and angular spacing.

4.) Features such as the door in Detail B, or the radial hole pattern, that extend past 0° or 360° will be drawn as shown, extending past the edge of the flat layout.

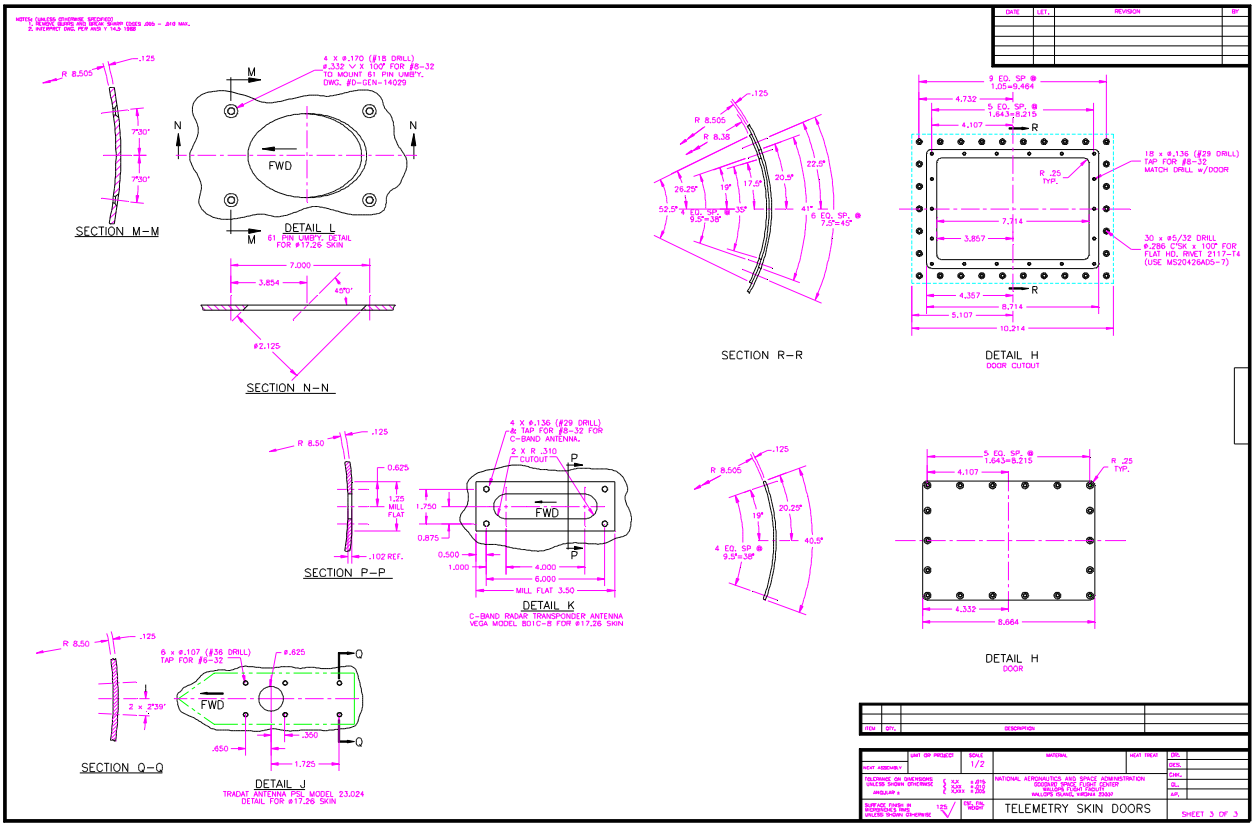


Figure 18: Sheet Three of a Typical Skin Drawing

Figure 18 shows sheet three of a typical Sounding Rocket skin drawing. This sheet will contain details of the features such as doors and umbilical cutouts shown on sheet two. In the case of standard items, these details can be found in the G:\DETAILS directory on the server. Always check the server first to see if a detail has already been drawn. Every effort will be made to keep them up to date. If a standard part detail is required that does not exist on the server, notify the drafting department so that it can be added.

This sheet will not always be necessary. For instance, a skin with no cutouts, or a simple radial hole pattern can have all the required dimensions on sheet one of two. In general, any skin with standard cutouts or doors, will show details for these items on a sheet three (and sheet four if needed).

1.9.2. Decks

All drawings used to describe decks with components mounted on one or both sides will conform to the following standards:

1.) Only one drawing will be created for each deck. Much confusion has been created in the past by sending more than one drawing to the shop for the same deck.

2.) All deck drawing views will be drawn such that 0 degrees is towards the top of the page. 0 degrees is understood to be the location of the launcher rail for rail launches.

3.) All deck drawings will include the text 0 DEG FWD SIDE in 1/8" high letters on the OBJECT layer on the forward side of the deck near 0 degrees as shown in Figure 19. The font will be AutoCAD ROMANS in order that the letters can be automatically machined into the deck.

4.) Deck material thickness will be specified in the title block as 3/8" STOCK PLATE rather than a dimension on the print such as .375" which indicates a tolerance of ± .005". Stock plate thickness is only required by the manufacturer to be within ± .020".

5.) A typical TM deck drawing is shown in Figure 19. It consists of three views of the deck and one or two sections of machining information as detailed in the following sections:

Machining View

One 1/2 scale view of the forward side of the deck looking towards the aft end of the rocket showing all component mounting holes will be included in all deck

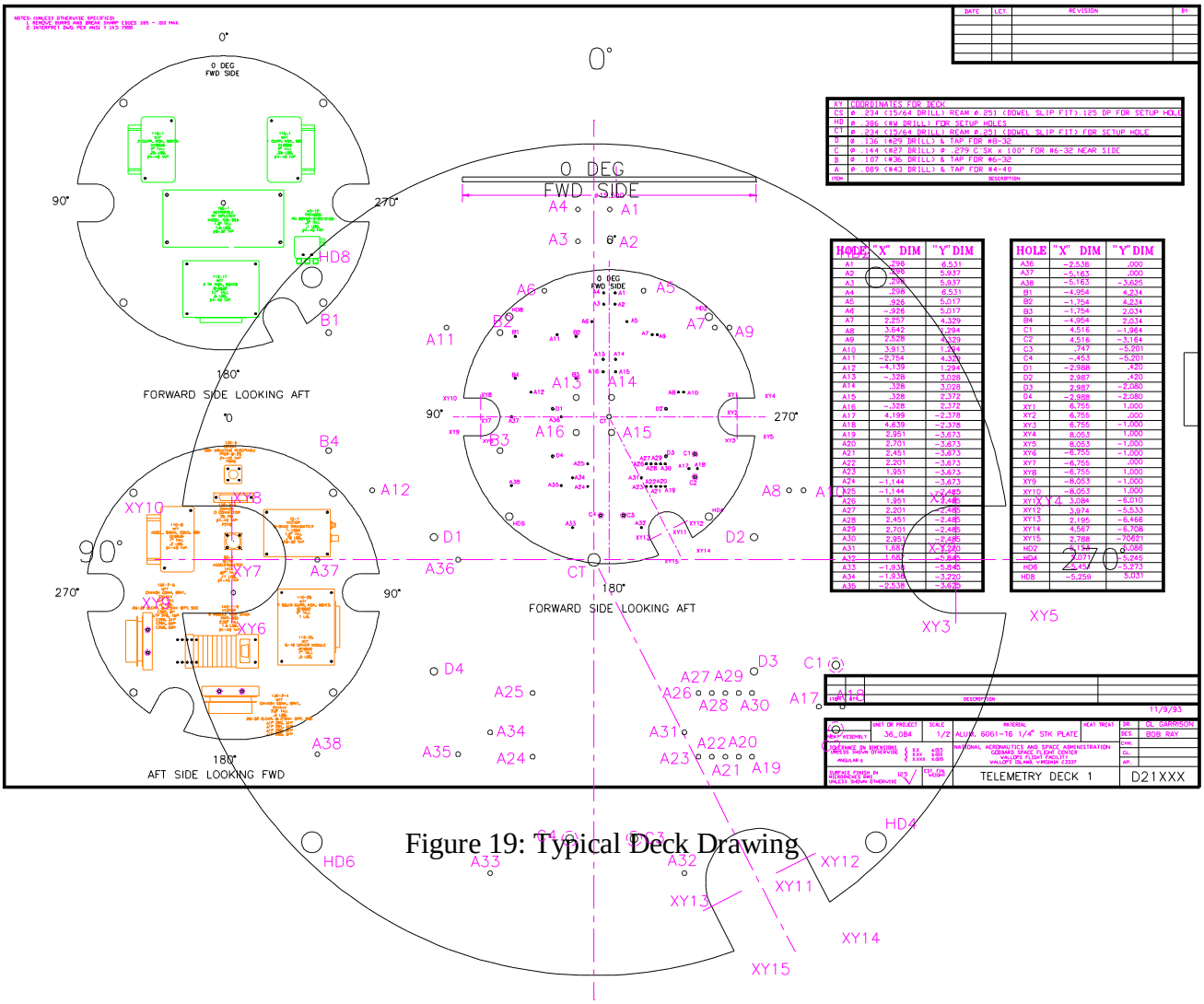


Figure 19: Typical Deck Drawing

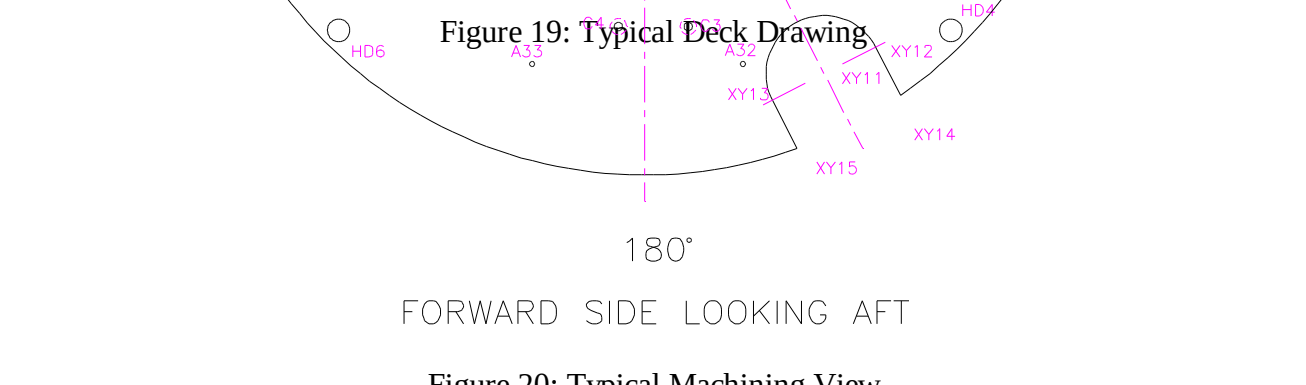


Figure 20: Typical Machining View

drawings. Each component mounting hole will be labeled with a letter indicating a machining operation (i.e., #10 clearance, drill and tap for #8-32, etc.) and a sequential number. The letters HD will always be used to indicate hold down holes used in manufacturing. CT will always indicate a center locating pin hole drilled through the deck. CS will indicate a center locating pin hole drilled 1/8" deep. The letters XY indicate coordinate points and centers of arcs that define the shape of the deck. This information will be added to the drawing only when requested by the machine shop. See Figure 20.

Forward Side View

One 1/2 scale view of the forward side of the deck looking towards the aft end of the rocket showing outlines of top side components along with descriptive notes will always be included. See Figure 21. Components will be inserted from the G:\SYMBOLS subdirectory on the file server in order for all information to be complete. If a component can not be found in this directory, notify the drafting department.

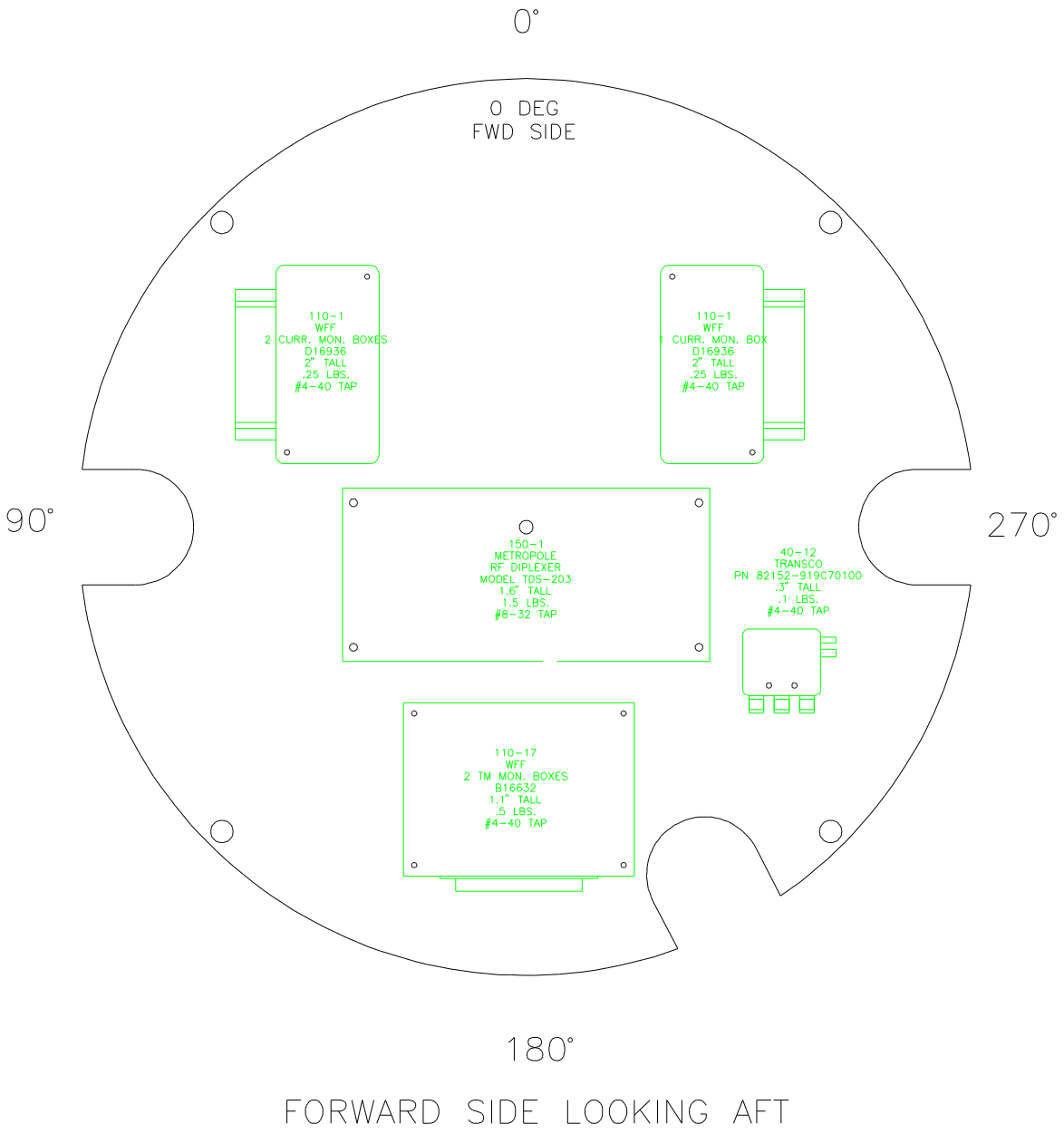


Figure 21: Typical Forward Side Component View

Aft Side View

One 1/2 scale view of the aft side of the deck looking towards the forward end of the rocket showing outlines of bottom side components along with descriptive notes will be included in all deck drawings. Again, components will be inserted from the symbol library on the file server.

An enlargement of the typical TM deck drawing is shown in Figure 22. Note that the connector bracket symbols include a list of connector numbers as well as their sizes, in the description. Also, the stack of three monitor boxes has two complete

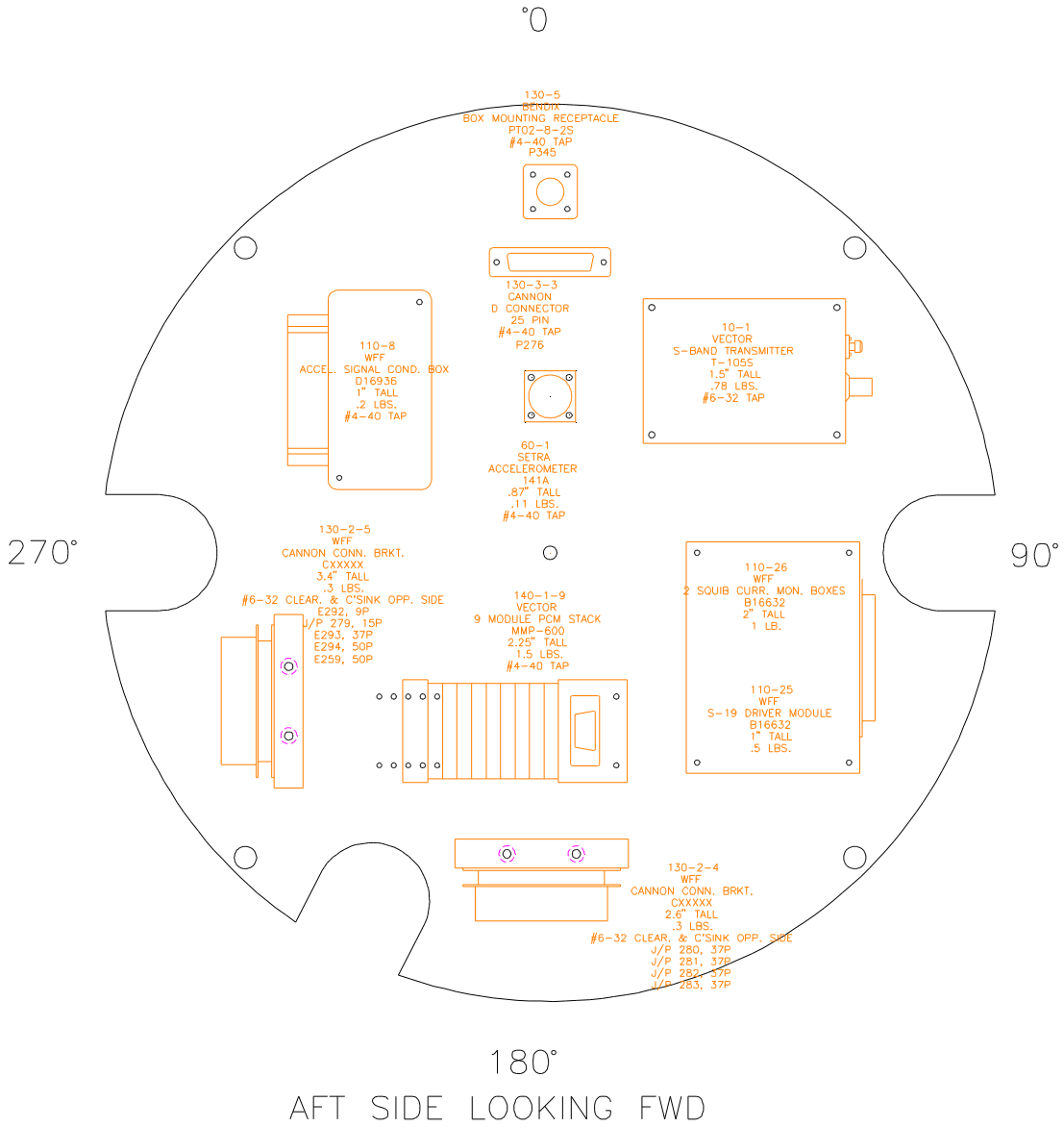


Figure 22: Typical Aft Side Component View

symbol descriptions, one for the single S-19 driver module box and one for the two current monitor boxes. The two symbols are actually inserted twice in the exact same location.

Coordinate Data (Optional)

One table will list x and y coordinates of each hole, arc center, arc start, arc end, or corner of the deck plate. The point 0,0 will always be at the center of the deck. Positive X will be to the right and positive Y will be straight up. See Figure 23.

This table will generally not be included on deck drawings due to the automated process of deck fabrication. If it is necessary for a deck to be fabricated on a

HOLE	"X" DIM	"Y" DIM
A1	.296	6.531
A2	.296	5.937
A3	.298	5.937
A4	.298	6.531
A5	.926	5.017
A6	-.926	5.017
A7	2.257	4.329
A8	3.642	1.294
A9	2.528	4.329
A10	3.913	1.294
A11	-2.754	4.329
A12	-4.139	1.294
A13	-.328	3.028
A14	.328	3.028
A15	.328	2.372
A16	-.328	2.372
A17	4.199	-2.378
A18	4.639	-2.378
A19	2.951	-3.673
A20	2.701	-3.673
A21	2.451	-3.673
A22	2.201	-3.673
A23	1.951	-3.673
A24	-1.144	-3.673
A25	-1.144	-2.485
A26	1.951	-2.485
A27	2.201	-2.485
A28	2.451	-2.485
A29	2.701	-2.485
A30	2.951	-2.485
A31	1.687	-3.220
A32	1.687	-5.845
A33	-1.938	-5.845
A34	-1.938	-3.220
A35	-2.538	-3.625

HOLE	"X" DIM	"Y" DIM
A36	-2.538	.000
A37	-5.163	.000
A38	-5.163	-3.625
B1	-4.954	4.234
B2	-1.754	4.234
B3	-1.754	2.034
B4	-4.954	2.034
C1	4.516	-1.964
C2	4.516	-3.164
C3	.747	-5.201
C4	-.453	-5.201
D1	-2.988	.420
D2	2.987	.420
D3	2.987	-2.080
D4	-2.988	-2.080
XY1	6.755	1.000
XY2	6.755	.000
XY3	6.755	-1.000
XY4	8.053	1.000
XY5	8.053	-1.000
XY6	-6.755	-1.000
XY7	-6.755	.000
XY8	-6.755	1.000
XY9	-8.053	-1.000
XY10	-8.053	1.000
XY11	3.084	-6.010
XY12	3.974	-5.533
XY13	2.195	-6.466
XY14	4.567	-6.708
XY15	2.788	-70621
HD2	5.153	5.086
HD4	5.071	-5.245
HD6	-5.451	-5.273
HD8	-5.259	5.031

Figure 23: Typical Coordinate Data

manual machine, or by manual input of coordinate data, the machine shop will request that this table be added to a drawing.

Machining Operation Key

The other table will be a key describing which machining operations are associated with which component mounting hole labels. As mentioned before, the labels HD, XY, CT, and CS will be standard for all drawings. The other labels may be different on each drawing. See Figure 24.

6.) The drawing will be created such that changes in any one of the views will automatically be made in the others. This can be accomplished in AutoCAD by using paper space, model space, multiple viewports, and several layers in addition to the standard ones. A drawing named G:\BORDER\DECK.DWG, has been created with all extra viewports and layers necessary to make a standard deck drawing. To use this as a prototype for a new deck drawing, follow these steps:

a.) Start AutoCAD if it is not already running.

b.) Click on New under the File menu.

c.) In the Prototype... field of the Create New Drawing dialog box enter G:\BORDER\DECK.

d.) In the Filename... box enter the name you wish to give your drawing.

e.) The drawing will come up on the screen with three 1/2 scale viewports, a 15.5" diameter circle representing a typical deck outline, and blank tables for X,Y coordinates and machining information. The 15.5" circle can be changed to represent the outline of the deck required, or just deleted in order to start a new deck outline.

f.) Make sure model space is active by entering MSPACE at the command prompt.

g.) Activate the machine view viewport by clicking the cursor anywhere inside this viewport.

XY	COORDINATES FOR DECK
CS	ø .234 (15/64 DRILL) REAM ø.251 (DOWEL SLIP FIT).125 DP FOR SETUP HOLE
HD	ø .386 (#W DRILL) FOR SETUP HOLES
CT	ø .234 (15/64 DRILL) REAM ø.251 (DOWEL SLIP FIT) FOR SETUP HOLE
D	ø .136 (#29 DRILL) & TAP FOR #8-32
C	ø .144 (#27 DRILL) ø .279 C'SK x 100° FOR #6-32 NEAR SIDE
B	ø .107 (#36 DRILL) & TAP FOR #6-32
A	ø .089 (#43 DRILL) & TAP FOR #4-40
ITEM	DESCRIPTION

Figure 24: Typical Machining Operation Key

h.) Insert any required components from the G:\SYMBOLS directory by choosing Insert from the Draw pull down menu and then clicking the File button in the Insert dialogue box. When the symbols are inserted they will come in as one block containing two views. The one in green represents the component to be mounted to the forward side of a deck; one in orange represents the same component to be mounted to the aft side of a deck. Explode the block and delete whichever view of the component that is not needed. The other view can then be moved to its proper location on the deck.

If the component text needs to be changed, moved, or rotated, the block must be exploded one more time (do not explode the block any further than this or all text information will be lost!). The command DDATTE can be used to change the text, while MOVE and ROTATE can be used to reposition it. Notice that the symbol only shows up in one of the two component mounting views. Orange components show up in the AFT SIDE LOOKING FORWARD view and green components show up in the FORWARD SIDE LOOKING AFT view.

Keep in mind that a symbol only needs to be inserted once from the symbols directory. If a component is used more than once, the second one must be created by clicking the Block button in the Insert dialogue box instead of the File button. This will bring up a list of available blocks to choose from. Never use the copy command to create more components!

i.) To add information to the title block, change back to paper space, and change layer to NOTE. Use the AutoCAD TEXT command to update the title block

j.) When it is time to make a plot of the drawing, freeze the COMP_AFT and COMP_FWD layers in the MACHINING VIEW viewport. This must cause the drawing to appear similar to the sample TM deck drawing shown previously.

7.) The following layers, colors, and linetypes, in addition to the standard ones described previously, will be used for deck drawings:

Layer Name	Color	Linetype
COMP_AFT	30 (orange)	continuous
	Component outlines and text descriptions of components mounted to the aft side of a deck will be put on this layer.	
COMP_FWD	green	continuous
	Component outlines and text descriptions of components mounted to the forward side of a deck will be put on this layer.	
HOLES_AFT	white	continuous

Mounting holes of components mounted to the aft side of a deck will be put on this layer.

HOLES_FWD white continuous
Mounting holes of components mounted to the forward side of a deck will be put on this layer.

VIEW_AFT white continuous
Any drawing entities that must only appear in the aft looking view must be put on this layer. This could include things such as the view label FWD SIDE LOOKING AFT.

VIEW_FWD white continuous
Any drawing entities that must only appear in the forward looking view must be put on this layer. This could include things such as the view label AFT SIDE LOOKING FORWARD.

VIEW_MACHINE magenta continuous
Any drawing entities that should only appear in the machining information view must be put on this layer. This includes items such as coordinate point labels and machining notes.

These layers have already been created in the symbol drawings and the prototype deck drawing. It will not be necessary to create them in a new deck drawing if the procedure in item 3 is followed.

8.) All non-sealed decks will include one .251" reamed through hole in the center for alignment on the milling machine fixture. Sealed decks will have a .125" deep hole rather than a through hole.

9.) All non-sealed decks will include at least four out of sixteen hold down holes as shown in Figure 25. At least one hole in each quadrant of the deck that does not interfere with any component mounting holes must be used. Sealed decks will not have any hold down holes.

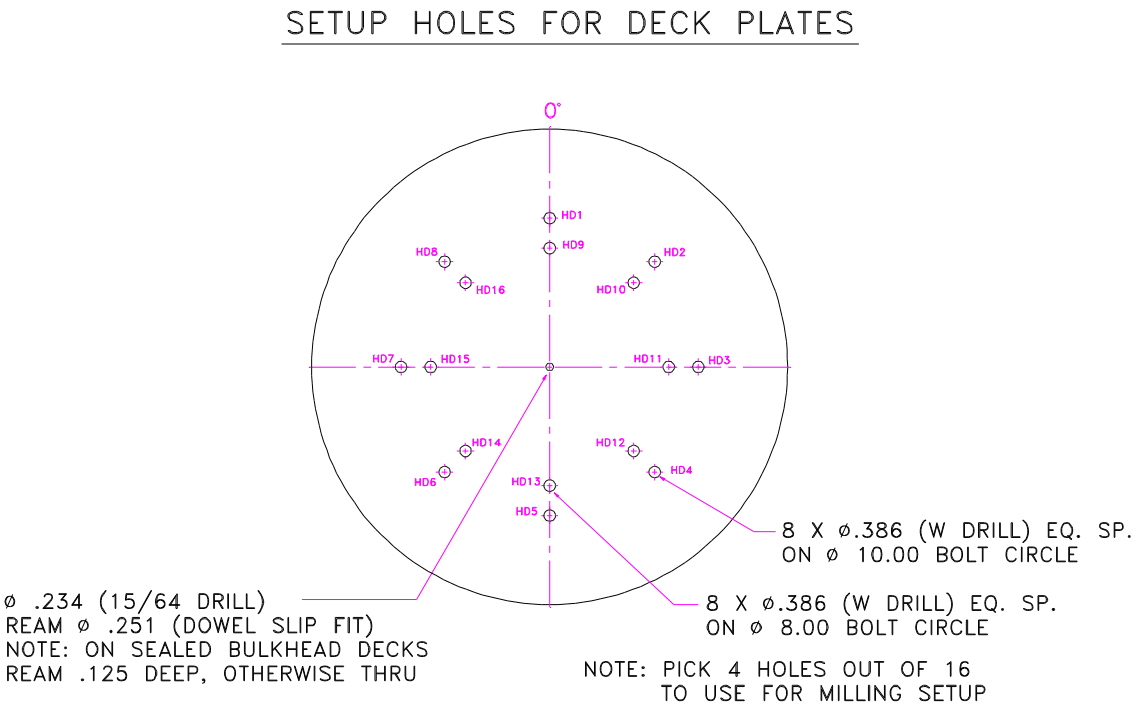


Figure 25: Hold Down Holes for Deck Machining Fixture

1.10. Inseparable Assembly Drawings

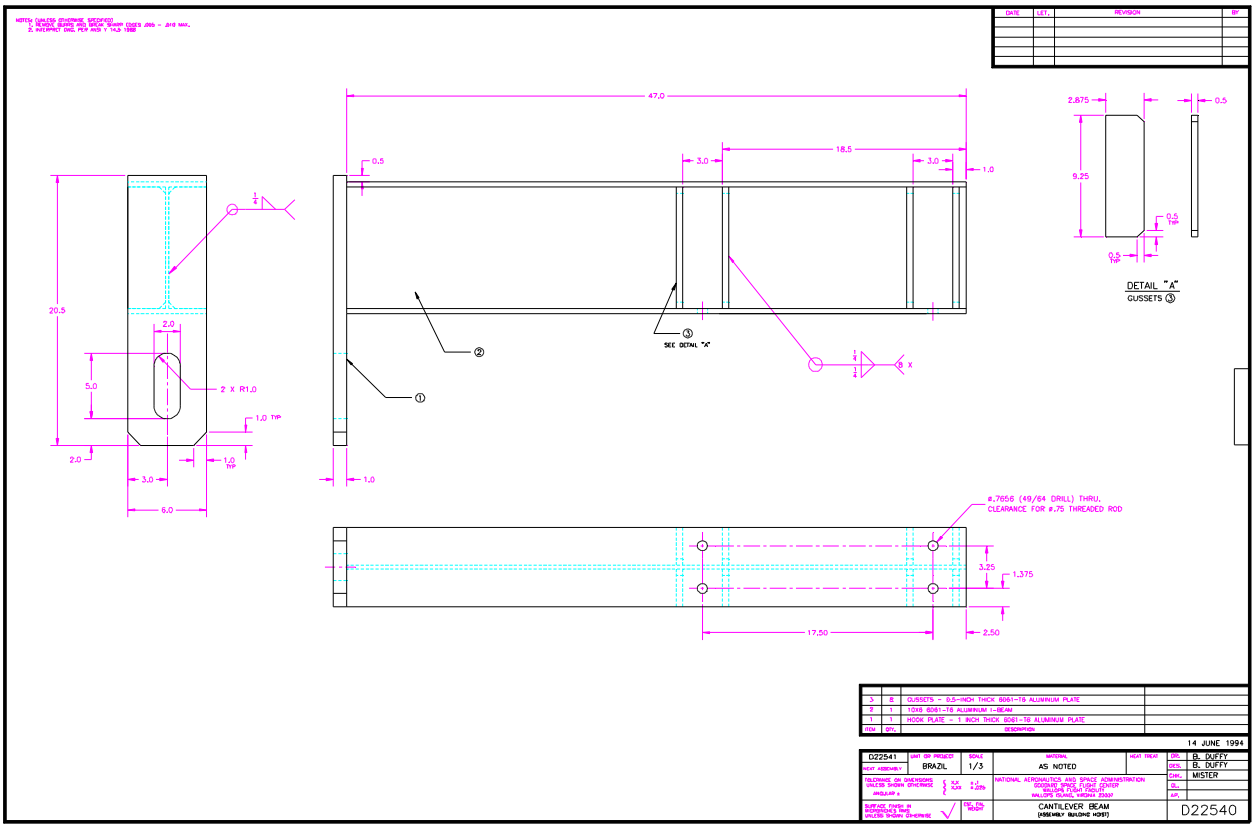


Figure 26: Inseparable Assembly Drawing

An inseparable assembly drawing delineates items which are separately fabricated and are permanently joined together (e.g. welded, brazed, riveted, bonded, nailed, etc.) to form an integral unit not capable of being readily disassembled. An Inseparable Assembly drawing may be prepared in lieu of individual monodetail drawings for inseparable assemblies intended to be procured and replaced as a unit, where (except for standard hardware) the separate parts are of similar or compatible materials. See Figure 26.

An inseparable assembly drawing shall fully define the end product or detail assembly as assembled. Pieces of the inseparable assembly may be detailed either on separate detail drawings or on the Inseparable Assembly drawing itself. In the case of weldments, the parts shall not be individually detailed on separate drawings (due to the consumable material allowances that would have to be shown on detail drawings), except in cases where extensive machining might be necessary.

1.11. Installation Assembly Drawing

An installation assembly drawing shows where and how parts and/or assemblies are installed relative to supporting structure or associated items. It shows locating dimensions, tolerancing, specifies attaching parts (such as rivets, bolts, or screws) and specific adjustments, operational instructions, and processes required for completing and inspection of the installation. See Figure 27.

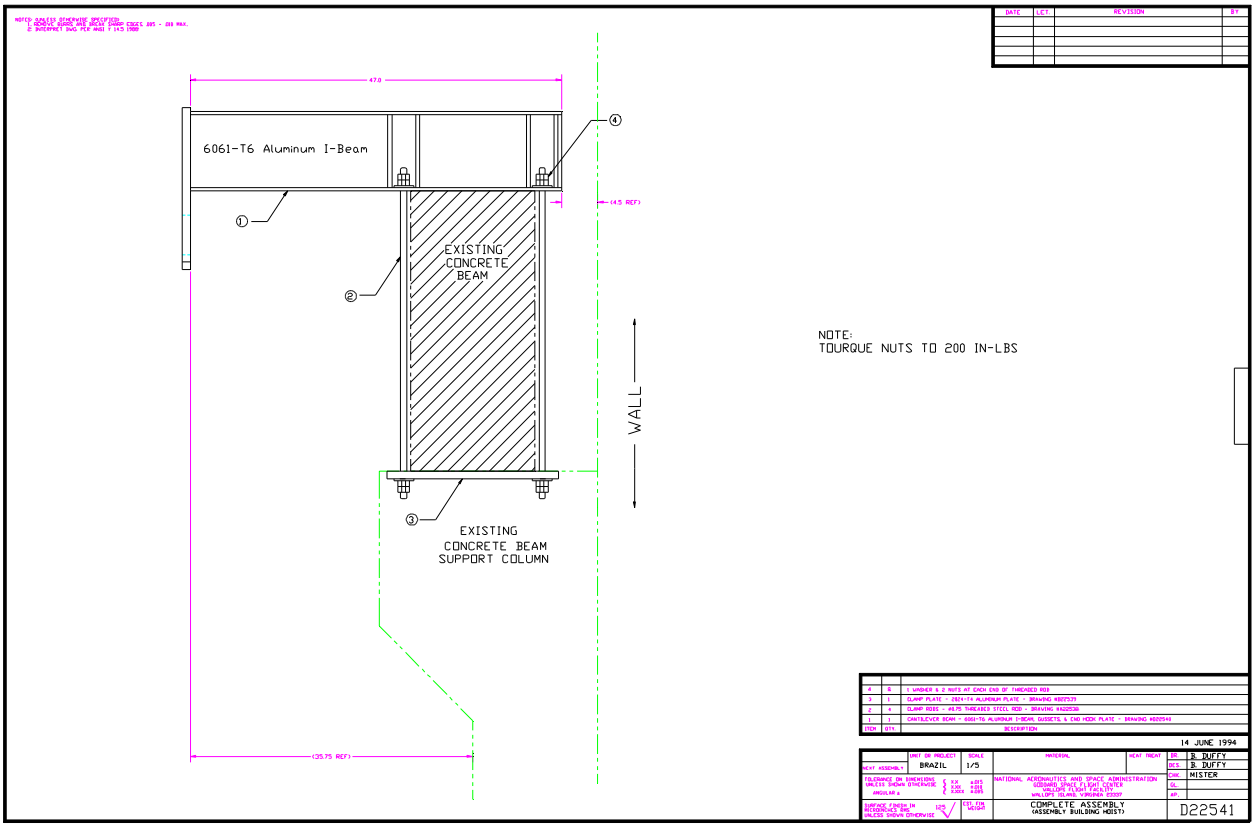


Figure 27: Installation Assembly Drawing

The following standards will be followed when creating an installation assembly drawing:

1.) That portion of the structure into which the installation is being installed shall be shown in phantom and identified by its part number. Such identifications shall be indicated as reference information by enclosure of the part number in parentheses or by use of the symbol "REF".

2.) Applicable datum points or planes, such as center lines of structure, plane of symmetry, station planes, etc., shall be shown and identified.

3.) Parts may be detailed in place on installation drawings when convenient.

1.12. Interface Control Drawing

An interface control drawing shall be used to maintain compatibility of physical and functional design between different engineering design activities. The drawing shall communicate design criteria such as dimensions, hardware, and ultimate changes relative to cofunctioning systems. "Interface Control Drawing" shall be added directly above the title block. See Figure 28.

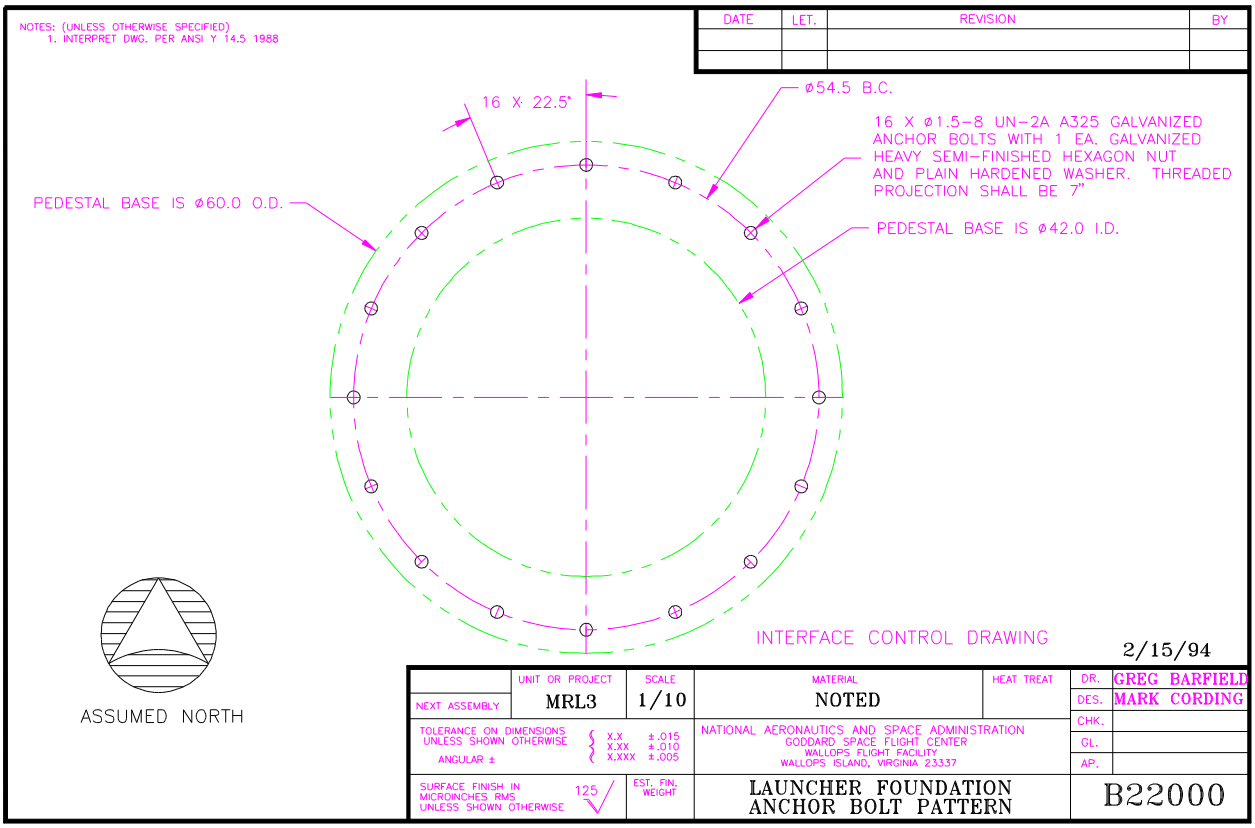


Figure 28: Interface Control Drawing

1.13. Source Control Drawing

A source control drawing shall be used to limit procurement of a vendor designed and manufactured part (or assembly) to that source or sources that exclusively provide the performance, installation, and interchangeable characteristics of the part selected and tested for a specific application. In the event the vendor shall not provide manufacturing drawings, the source control drawing shall include the same description of the part as required on specification control drawings. If vendor drawings are made available, the content of the source control drawing shall be limited to vendor's part number, name, and address. In either case, the following note shall appear on the source control drawing: "Only the part(s) specified on this drawing and identified by vendor's name(s), address(es), and part number(s) has (have) been tested and approved by WFF for use in (item)". A substitute part shall not be used without prior testing and approval by the responsible engineer. See Figure 29.

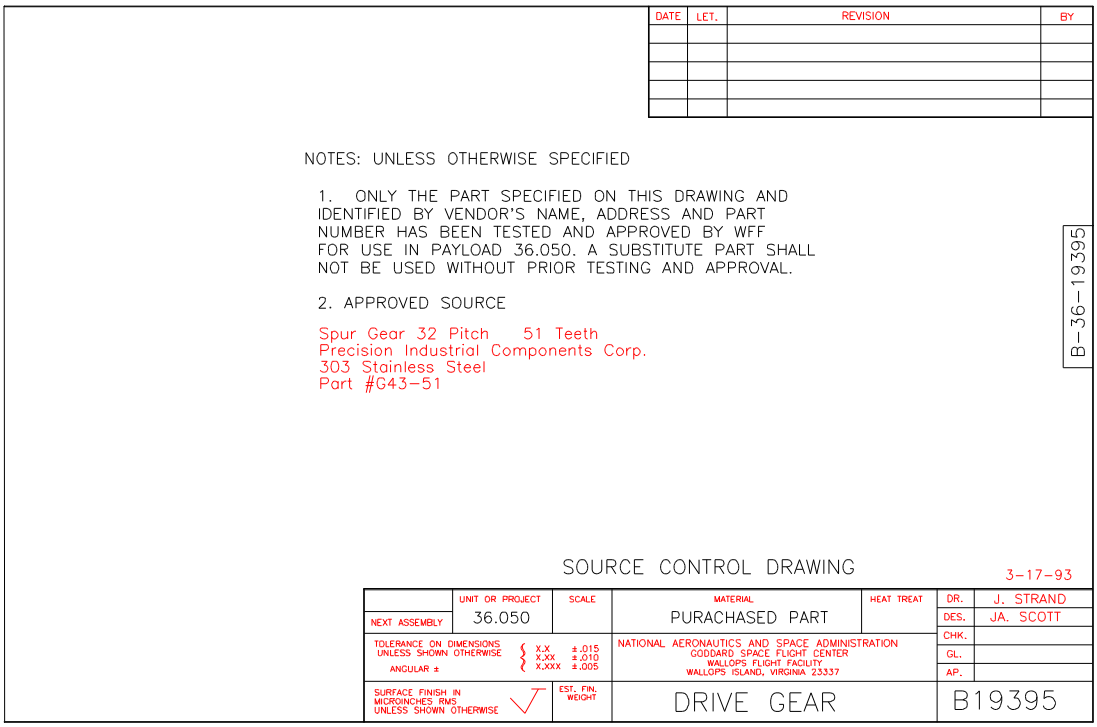


Figure 29: Source Control Drawing

The following standards will be adhered to when creating a source control drawing:

1.) The source control drawing number is not a part number. The vendor part itself shall be identified by the vendor's identifying number.

2.) The assembly (or installation) drawing shall call out the part by source control drawing number. In the parts list of the drawing, the source control drawing number shall be accompanied by the following note: "Vendor Part--see source control drawing". A source control drawing shall be identified by the words "Source Control Drawing" immediately above the title block.

3.) A source control drawing shall not upgrade a vendor's part beyond the vendor's stipulations.

1.14. Specification Control Drawings

Specification control drawings are prepared to record the characteristics of a vendor designed and manufactured part (or assembly). Such characteristics are size, shape, mounting dimensions, electrical specifications, and other design requirements, including tests, when applicable. This is information that could be obtained from the vendor's manufacturing drawings if they were made available. The vendor's part number, name, and address shall be included. This type of drawing may also be used to document WFF parts that are sent to a unique vendor to perform a specific operation because of special equipment and/or hardware only available there. See Figure 30.

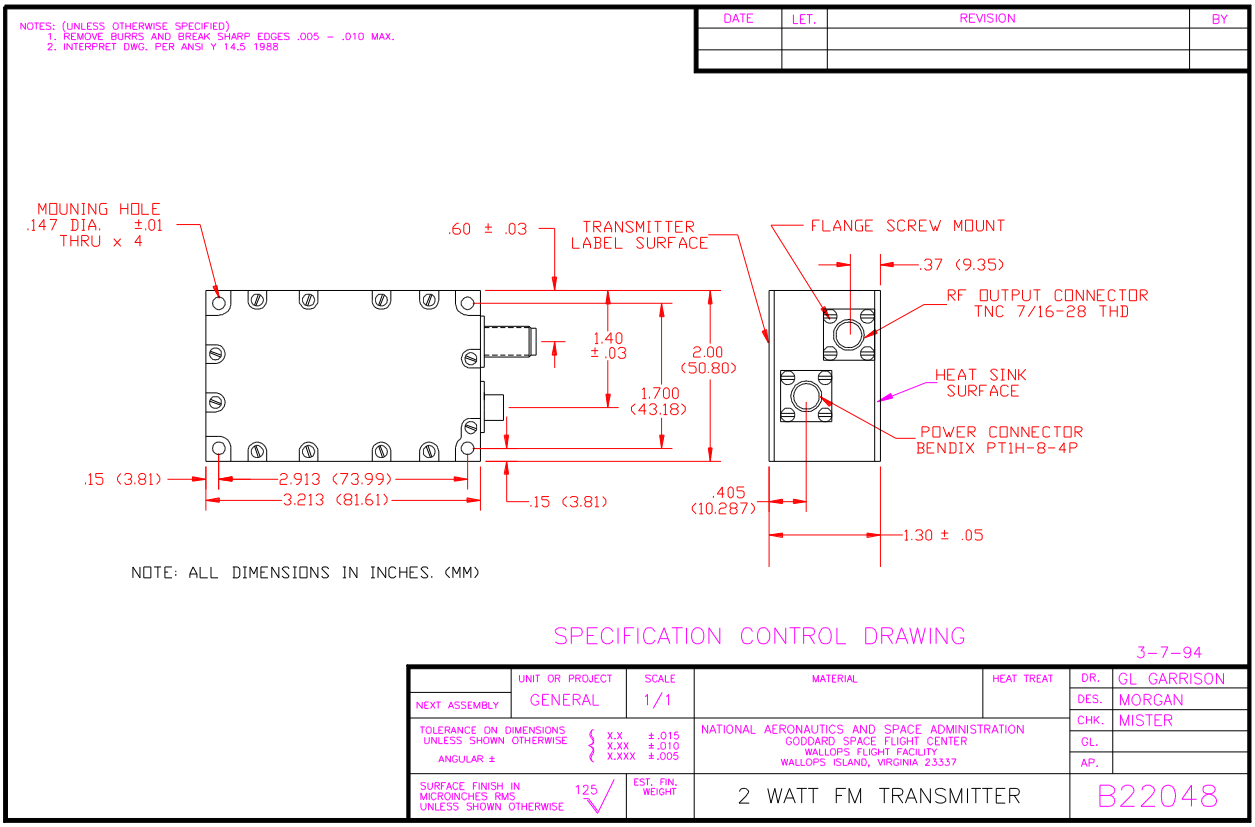


Figure 30: Specification Control Drawing

The following standards will be adhered to when creating a specification control drawing.

1.) The specification control drawing number is not a part number. The vendor part itself shall be identified by the vendor's identifying number.

2.) The assembly (or installation) drawing shall call out the part by the specification control drawing number. In the parts list of the drawing, the specification control drawing number shall be accompanied by the note "Vendor Part--see specification control drawing". A specification control drawing shall be identified by the words "Specification control drawing" immediately above the title block.

3.) A specification control drawing does not prevent procurement from multiple sources when the vendor part has been determined to be equivalent to other vendor parts by the Federal Cataloging Program, resulting in Federal Item Identification Number (FIIN) number assignment or when the part is manufactured by a licensee of the vendor.

4.) The preparation of specification control drawings can be avoided by procuring the vendor's manufacturing drawings. In the event the vendor claims proprietary rights and refuses to provide his manufacturing drawings, he shall be requested to furnish an outline drawing of his part sufficient to include the requirements stated above. When the vendor provides either type of drawing, the part number callout on the drawing shall be by the vendor's number.

5.) A specification control drawing shall not upgrade a vendor's part beyond the vendor's stipulations.

1.15. Tabulated Drawings

A tabulated drawing depicts similar items with differences in characteristics such as dimensions, material, finish, and other requirements. These differences are tabulated on the drawing, the fixed characteristics depicted once.

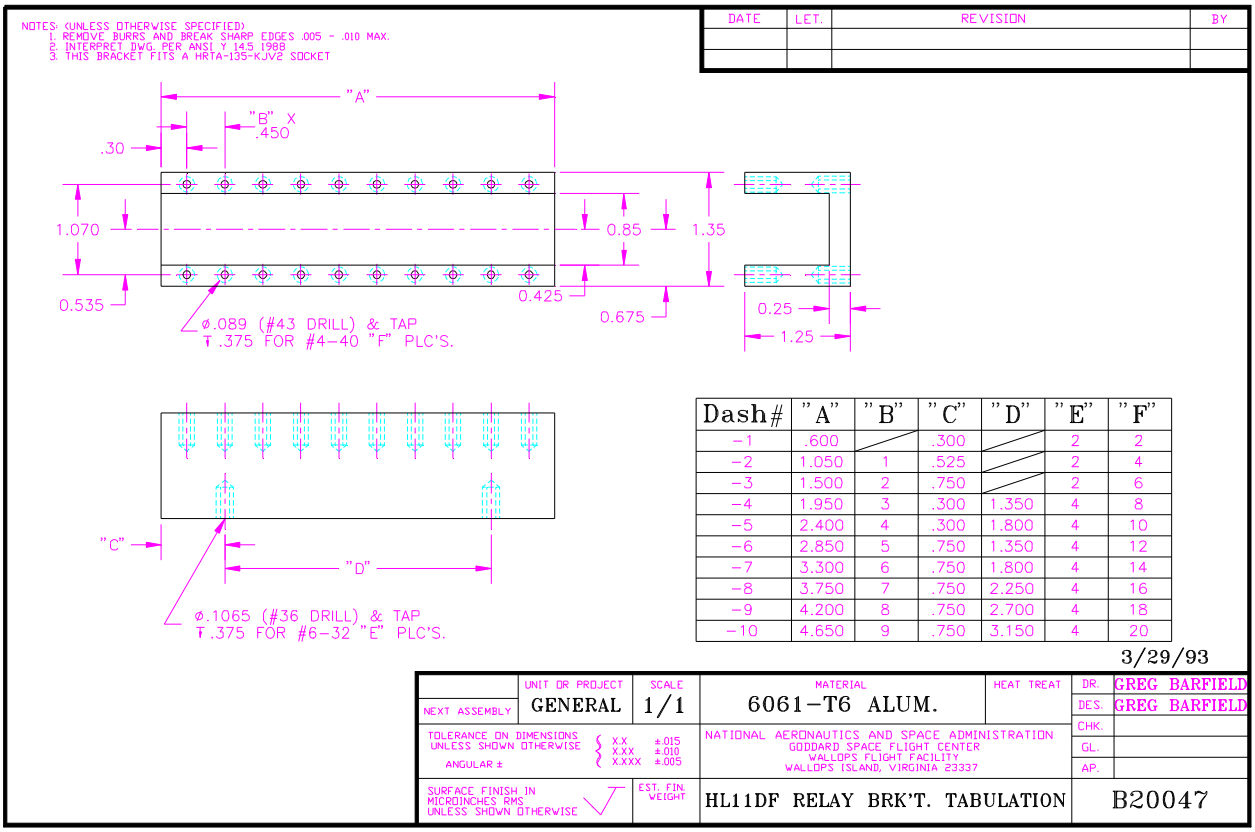


Figure 31: Tabulated Drawing

Pictorial differences that are not clear must be shown in views or details and must be properly labeled. A tabulated drawing precludes the preparation of an individual drawing for each item. See Figure 31.

1.16. Modification Drawings

Modification drawings delineate changes to delivered items, stockable items, assemblies, installations, or systems. Drawings are prepared to add, remove, or rework items, equipment installations, or systems to satisfy the using activity's requirements. They also incorporate mandatory changes (e.g., safety, reliability, or application extension) in delivered equipment. A modification drawing shall be identified by the words MODIFICATION DRAWING immediately above the title block. See Figure 32.

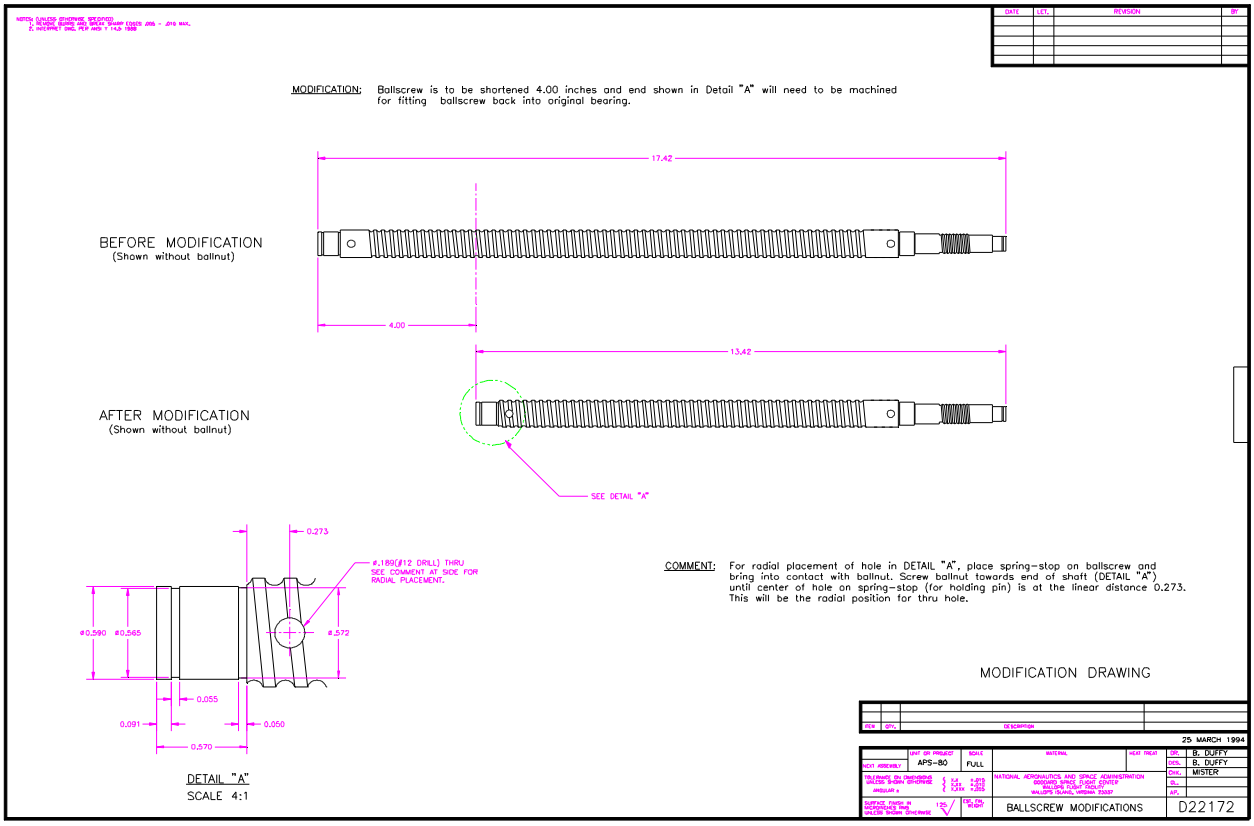


Figure 32: Modification Drawing

1.17. Electrical Drawings

Electrical and electronic drawings are prepared to depict schematics, wiring diagrams, cable interconnections, and detailed cable assembly drrawings.

Generally accepted symbols and notations shall be used. When choice of symbol is ambiguous, it shall be clearly conveyed by notation or reference to the standard being used.

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	08/19/1999	Initial Release